Q1

The resistance of a wire is 20Ω. It is stretched, so that the length becomes three times, then the new resistance of the wire will be

(1) 200Ω

(2) 160Ω

(3) 120Ω

(4) 180Ω

Q2

A standing wave in a pipe with a length $L = 1.2$ m is described by
$y(x,t) = y_0 \sin[(2\pi/L)x] \sin[(2\pi/\mathrm{T})t + \pi/4]$
Based on above information, which one of the following statements is incorrect. (Speed of sound in air is 300 m s^{-1})-

(1) The pipe is closed at both ends

(2) The wavelength of the wave could be 1.2 m

(3) There could be a node at $x = 0$ and antinode at $x = \mathrm{L}/2$

(4) The frequency of the fundamental mode of vibrations is 137.5 Hz

Q3

300 cc of a gas at the atmospheric pressure of 10^6 dyne cm^{-2} is compressed to 150 cc. If the change is sudden, what is final pressure? Given $\gamma = 1.4$

(1) 1×10^6 dyne cm^{-2}

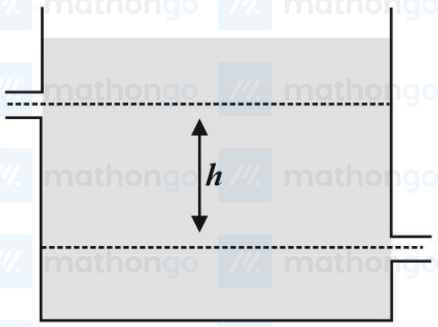
(2) 2.0×10^6 dyne cm^{-2}

(3) 2.6×10^6 dyne cm^{-2}

(4) 3.0×10^6 dyne cm^{-2}

Q4

There are two identical small holes of area of cross-section A on the opposite sides of a tank containing a liquid of density ρ. The difference in height between the holes is h. Tank is resting on a smooth horizontal surface, horizontal force which has to be applied on the tank to keep it in equilibrium is



(1) $\rho g h A$

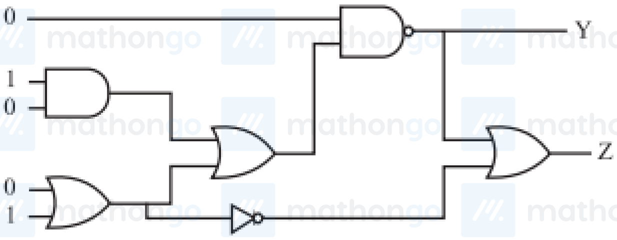
(2) $2 g h / \rho A$

(3) $2 \rho g h A$

(4) $\rho g h / A$

Q5

The values of Y and Z in the given logic circuit are



(1) $Y=1, Z=1$

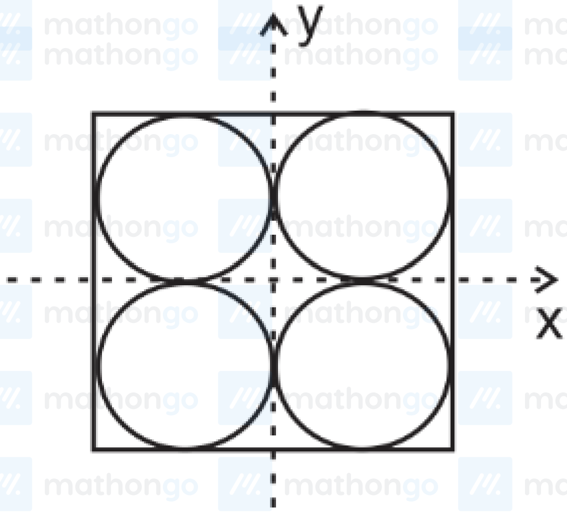
(2) $Y=0, Z=1$

(3) $Y=1, Z=0$

(4) $Y=0, Z=0$

Q6

Four holes of radius R are cut from a thin square plate of side 4R and mass M. The moment of inertia of the remaining portion about z-axis is



(1) $\frac{\pi}{12}\mathrm{MR}^2$

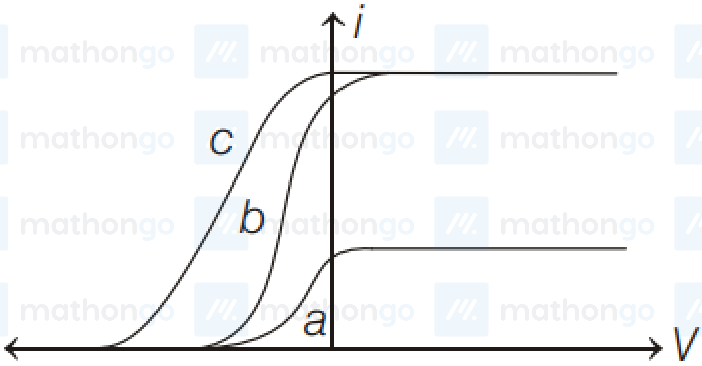
(2) $\left(\frac{4}{3}-\frac{\pi}{4}\right)\mathrm{MR}^2$

(3) $\left(\frac{8}{3}-\frac{10\pi}{16}\right)\mathrm{MR}^2$

(4) $\left(\frac{4}{3}-\frac{\pi}{6}\right)\mathrm{MR}^2$

Q7

The figures shows the variation of photocurrent i with anode potential V for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b and c respectively. Then



(1) $f_a = f_b$ and $I_a \neq I_b$

(2) $f_a = f_c$ and $I_a = I_c$

(3) $f_a = f_b$ and $I_a = I_b$

(4) $f_b = f_c$ and $I_b = I_c$

Q8

A liquid A of mass 100 g at 100˚C is added to 50 g of a liquid B at temperature 75˚C, the temperature of the mixture becomes 90˚C. Now if 100 g of liquid A at 100˚C is added to 50 g of liquid B at 50˚C, temperature of the mixture will be

(1) 80˚C

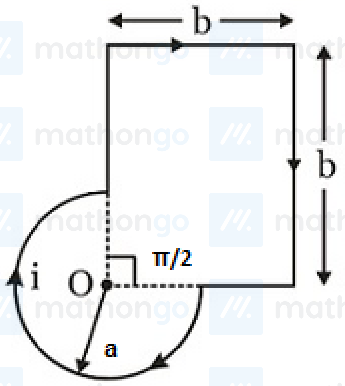
(2) 60˚C

(3) 70˚C

(4) 85˚C

Q9

The magnitude of the magnetic field at O (centre of the circular part) due to the current-carrying coil as shown is:



(1) $\frac{\mu_0 i}{4\pi}\left(\frac{4\pi}{a}+\frac{\sqrt{2}}{b}\right)$

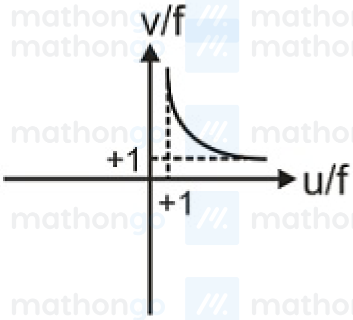
(2) $\frac{\mu_0 i}{4\pi}\left(\frac{3\pi}{2a}+\frac{\sqrt{2}}{b}\right)$

(3) $\frac{\mu_0 i}{2\pi}\left(\frac{\pi}{3a}+\frac{3}{\sqrt{2}b}\right)$

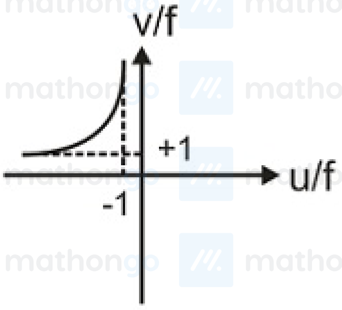
(4) $\frac{\mu_0 i}{4\pi}\left(\frac{3\pi}{a}+\frac{\sqrt{2}}{b}\right)$

Q10

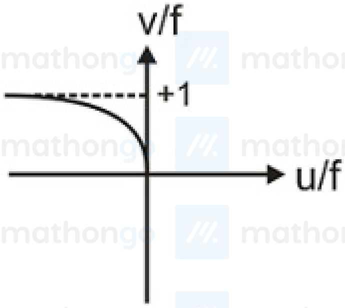
A real inverted image in a concave mirror is represented by graph (u, v, f are coordinates)



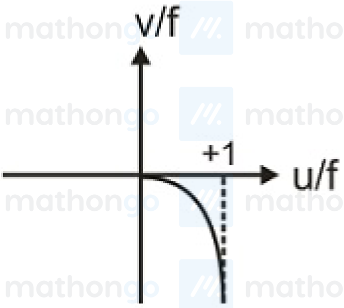
(1)



(2)



(3)



(4)

Q11

Match the electromagnetic radiations given in List -I with their uses given in List - II.

List - I		List - II
A) X-rays	P)	Remote switches
B) UV-rays	Q)	Finger prints in forensic Labs
C) Radio waves	R)	Crystal structure study
D) IR - rays	S)	TV communication system.

(1) $\mathrm{A} \rightarrow \mathrm{Q}, \mathrm{B} \rightarrow \mathrm{R}, \mathrm{C} \rightarrow \mathrm{P}, \mathrm{D} \rightarrow \mathrm{S}$

(2) $\mathrm{A} \rightarrow \mathrm{R}, \mathrm{B} \rightarrow \mathrm{Q}, \mathrm{C} \rightarrow \mathrm{S}, \mathrm{D} \rightarrow \mathrm{P}$

(3) $\mathrm{A} \rightarrow \mathrm{R}, \mathrm{B} \rightarrow \mathrm{S}, \mathrm{C} \rightarrow \mathrm{Q}, \mathrm{D} \rightarrow \mathrm{P}$

(4) $\mathrm{A} \rightarrow \mathrm{S}, \mathrm{B} \rightarrow \mathrm{R}, \mathrm{C} \rightarrow \mathrm{Q}, \mathrm{D} \rightarrow \mathrm{P}$

Q12

A particle is moving on X-axis has potential energy $U=2-20x+5x^2\ \mathrm{J}$ along X-axis. The particle is released at $x=-3$. The maximum value of x will be (x is in metre and U is in joules)

(1) $5\ \mathrm{m}$

(2) $3m$

(3) $7\ \mathrm{m}$

(4) $9\ \mathrm{m}$

Q13

In a double-slit experiment, the distance between slits is increased 10 times, whereas their distance from screen is halved, then the fringe width

(1) Becomes $\frac{1}{20}$th

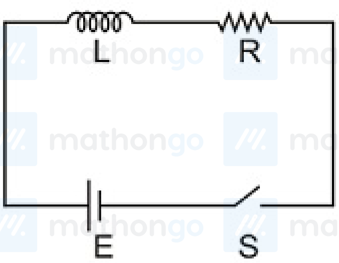
(2) Becomes $\frac{1}{90}$th

(3) Remains same

(4) Becomes $\frac{1}{10}$th

Q14

In the circuit shown in diagram, switch S is closed at time $t = 0$. The charge which passes through the battery in one time constant is



(1) $\frac{eR^2E}{L}$

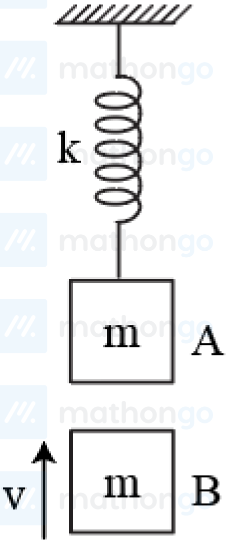
(2) $\frac{EL}{R}$

(3) $\frac{EL}{eR^2}$

(4) $\frac{eL}{ER}$

Q15

Block ' A ' is hanging from a vertical spring and is at rest. Block ' B ' strikes the block ' A ' with velocity ' v ' and sticks to it. Then the value of ' v ' for which the spring just attains natural length is -



(1) $\sqrt{\frac{60\text{mg}^2}{k}}$

(2) $\sqrt{\frac{6\text{mg}^2}{k}}$

(3) $\sqrt{\frac{10\text{mg}^2}{k}}$

(4) None of these

Q16

A ball rolls off the top of stair-way with a horizontal velocity of magnitude $1.8\ \mathrm{m\ s^{-1}}$. The steps are $0.20\ \mathrm{m}$ high and $0.20\ \mathrm{m}$ wide. Which step will the ball hit first?

(1) First

(2) Second

(3) Third

(4) Fourth

Q17

The distance moved by the screw of a screw gauge is 2 mm in four rotations and there are 50 divisions on its cap. When nothing is put between its jaws, 30th division of circular scale coincides with the reference line, with zero of circular scale lying above the reference line. When a plate is placed between the jaws, the main scale reads 2 divisions and the circular scale reads 20 divisions. The thickness of the plate is

(1) 1.5 mm

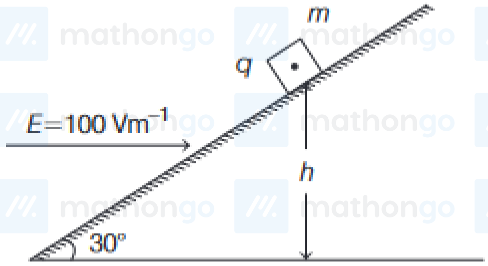
(2) 1.2 mm

(3) 1.4 mm

(4) 1.6 mm

Q18

An inclined plane making an angle 30° with the horizontal is placed in a uniform horizontal electric field of $100 \mathrm{Vm}^{-1}$ as shown in the figure. A small block of mass $1 \mathrm{kg}$ and charge, 0.01C is allowed to slide down from rest from a height, $h=1\ \mathrm{m}$. If the coefficient of friction is 0.2 , then the acceleration of the block is nearly,
(Acceleration due to gravity, $g=10\ \mathrm{ms}^{-2}$)



(1) $1.4\ \mathrm{ms}^{-2}$

(2) $2.4\ \mathrm{ms}^{-2}$

(3) $3.4\ \mathrm{ms}^{-2}$

(4) $4.4 \mathrm{~ms}^{-2}$

Q19

A gas mixture consists of 2 moles of oxygen and 4 moles of argon at temperature T. Neglecting all vibrational modes we calculated the total internal energy of the system to be xRT. What is the value of x?

(1) 10

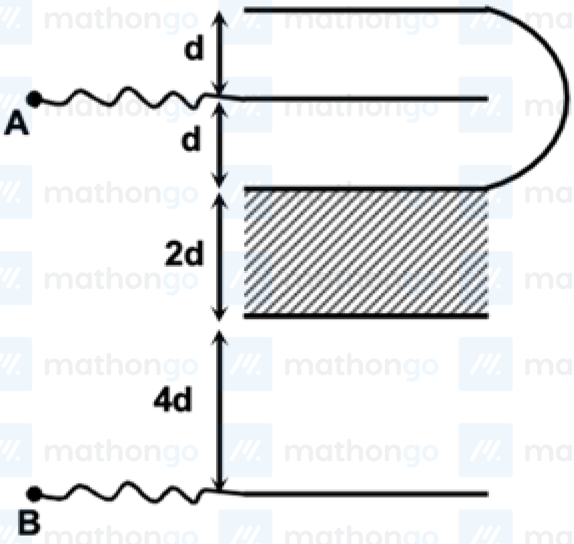
(2) 9

(3) 13

(4) 11

Q20

In the arrangement shown, a dielectric slab of dielectric constant $k=2$ is completely filled in the shaded region. All the plates have same area S. Find the equivalent capacitance between A and B. (Given $\frac{\varepsilon_0 S}{d}=1 \mu F$)



(1) $\frac{2}{11} \mu$f

(2) $\frac{4}{11} \mu f$

(3) $\frac{7}{22} \mu$f

(4) $\frac{9}{22} \mu$f

Q21

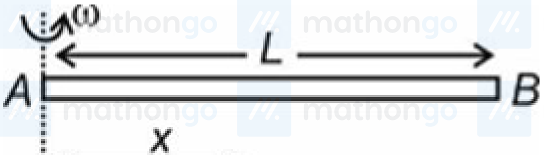
An unknown resistance R_1 is connected in series with a resistance of $10\ \Omega$. This combination is connected to one gap of the meter bridge while a resistance R_2 is connected in the other gap. The balance point is at $50\ \text{cm}$, Now, when the $10\ \Omega$ resistance is removed the balance point shifts to $40\ \text{cm}$. The value of R_1(in ohm) is

Q22

A hydrogen-like atom (atomic number Z) is in a higher excited state of quantum number n. This excited atom can make a transition to the first excited state by successively emitting two photons of energies $10.20\ \text{eV}$ and $17.00\ \text{eV}$ respectively. Alternatively, the atom from the same excited state can make a transition to the second excited state by successively emitting two photons of energy $4.25\ \text{eV}$ and $5.95\ \text{eV}$ respectively. Determine the value of Z. [Ionization energy of hydrogen atom $= 13.6$ eV]

Q23

A non-conducting rod of length L with linear charge density $\lambda = \lambda_0 x$ where x is the distance from end A is rotating with constant angular speed ω about the same end. If the angular velocity of the rod (ω) is large, then the magnetic dipole moment of the system is $\frac{\omega \lambda_0 L^4}{n}$. What is the value of n?

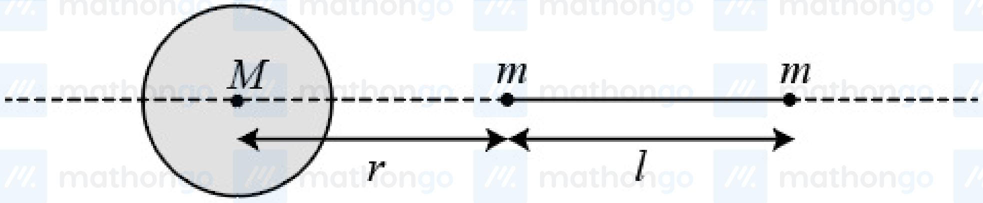


Q24

Two persons A and B are located in $X - Y$ plane at the points $(0, 0)$ and $(0, 10)$ respectively. (The distances are measured in MKS unit). At a time $t = 0$, they start moving simultaneously with velocities $\overrightarrow{\mathrm{v}}_A = 2\hat{\jmath}\mathrm{ms}^{-1}$ and $\overrightarrow{\mathrm{v}}_B = 2\hat{\imath}\mathrm{ms}^{-1}$ respectively. The time after which A and B are at their closest distance is t sec, find $2t$.

Q25

A large sphere of mass M is fixed at one position and two identical particles each of mass m are kept on a line passing through the centre of M (see figure). The point masses are connected by a rigid massless rod of length l and this assembly is free to move along the line connecting them. All three masses interact only through their mutual gravitational interaction. When the point mass nearer to M is at a distance $r = 3\mathrm{l}$ from M, the tension in the rod is zero for $m = k\left(\frac{M}{288}\right)$. The value of k is



Q26

List I contain pair of solute and solvent and List II contain properties of their resulting solution.

	List-I		List-II
(P)	n-hexane + $n-$ heptane	(1)	$\Delta H_{\text{mixing}} = 0$
(Q)	CS_2 + Acetone	(2)	$\Delta H_{\text{mixing}} \neq 0$
(R)	$CHCl_3$ + Acetone	(3)	Minimum boiling azeotrope can be formed
(S)	Benzene + toluene	(4)	Maximum boiling azeotrope can be formed
		(5)	$P_S = P_A^\circ X_A + P_B^\circ X_B$ $P_S \rightarrow$ vapour pressure of solution $P_A^\circ \rightarrow$ vapour pressure of pure solute $P_B^\circ \rightarrow$ vapour pressure of pure solvent $X_A \rightarrow$ mole fraction of solute $X_B \rightarrow$ mole fraction of solvent

(1) $P \rightarrow 1,5; Q \rightarrow 2,3; R \rightarrow 2,5; S \rightarrow 2,3$

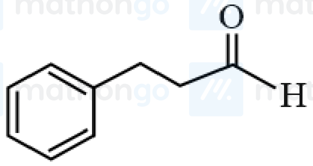
(2) $P \rightarrow 2,4; Q \rightarrow 2,3; R \rightarrow 2,5; S \rightarrow 2,4$

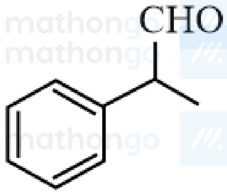
(3) $P \rightarrow 2,3; Q \rightarrow 1,5; R \rightarrow 4,5; S \rightarrow 1,5$

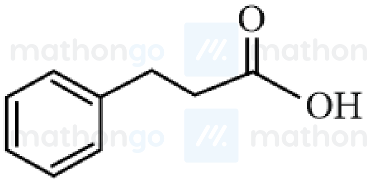
(4) $\mathrm{P} \rightarrow 1,5; \mathrm{Q} \rightarrow 2,3; \mathrm{R} \rightarrow 2,4; S \rightarrow 1,5$

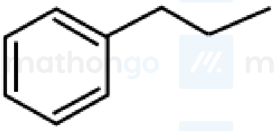
Q27

In the presence of peroxide, styrene reacts with HBr to give X. When X reacted with magnesium in dry ether followed by CO_2 and hydrolysis gave Y. Treatment of Y with PCl_5 and then next with H_2, Pd $-$ $BaSO_4$ gave Z. What is Z?

(1)


(2) 

(3) 

(4) 

Q28

pH of aqueous solution of one of the following salts is independent of its concentration. The salt is:

(1) CH_3COONa

(2) $C_6H_5NH_3Cl$

(3) $PbCl_2$

(4) CH_3COONH_4

Q29

Which of the following is not correct?

(1) $FeCl_3 + KCNS \longrightarrow$ Red colour

(2) $KI + PbCl_2 \longrightarrow$ Yellow ppt.

(3) NH_4Cl+ Nesseler 's reagent $\longrightarrow$ Blue colour

(4) $DMG + Ni^{2+} + NH_4OH \longrightarrow$ Scarlet red ppt.

Q30

He^+ ions in its ground state are irradiated with photons of energy $67.15 eV$. Electrons ejected from He^+ strikes the H-atom in its ground state. Give the maximum number of spectral lines which can be obtained from de-excitation of H-atoms.

(1) 12

(2) 4

(3) 8

(4) 6

Q31

Given the electronic configurations of few elements. Select the incorrect Match:

1	$1s^2 2s^2 2p^5$	Most electronegative element in the periodic table
2	$1s^2 2s^2 2p^3$	An element belonging to 3^{rd} period and 5^{th} group
3	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$	A d-block element
4	$1s^2 2s^2 2p^6 3s^2 3p^6$	An element from 18^{th} group

(1) 1 and 4 only

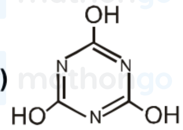
(2) 2 only

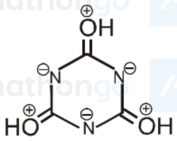
(3) 1, 2 and 3

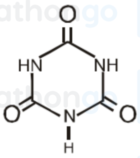
(4) All are the incorrect matches.

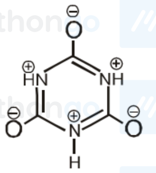
Q32

The correct statement(s) concerning the structures $P, Q, R \& S$ is/are :

(P)


(Q)


(R)


(S)


A - Q & S are tautomers.
B - R & S are resonating structures.
C - P & R are tautomers.
D - P & Q are resonating structures.

(1) A,B,C Only

(2) A,B,C,D

(3) A,B Only

(4) C,D Only

Q33

A Complex P of composition $\mathrm{Cr}\left(\mathrm{H}_2\mathrm{O}\right)_6\ \mathrm{Br}_{\mathrm{n}}$ has a spin only magnetic moment of 3.83 BM. It reacts with AgNO_3 and shows geometrical isomerism. The IUPAC nomenclature of P is

(1) Hexaaqua chromium (III) bromide

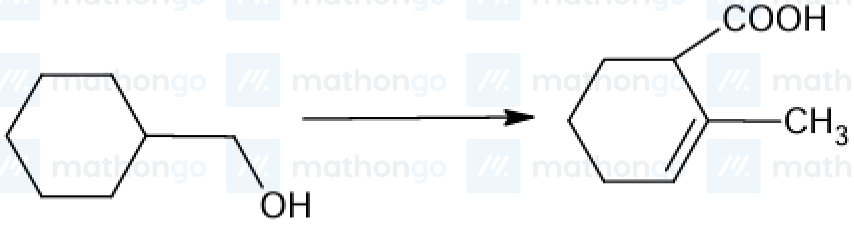
(2) Dibromidotetraaqua chromium (IV) bromide dihydrate

(3) Tetraaquadibromido chromium (IV) bromide dihydrate

(4) Tetraaquadibromido chromium (III) bromide dihydrate

Q34

The correct order of reagents required to bring the following change is:



(1) $\mathrm{H_3O^+}; \mathrm{KCN}; \mathrm{NBS}; K_2\mathrm{Cr_2O_7/H^+}$

(2) $K_2\mathrm{Cr_2O_7/H^+}; \mathrm{Cl_2/KOH}; \mathrm{CH_3MgBr}; \mathrm{H_3O^+}$

(3) conc. $\mathrm{H_2SO_4}; \mathrm{NBS}; \mathrm{KCN}; \mathrm{H_3O^+}$

(4) Conc. $\mathrm{H_2SO_4}; \mathrm{NBS}; \mathrm{CH_3MgBr}; K_2\mathrm{Cr_2O_7/H^+}$

Q35

Arrange $\mathrm{Yb^{+3}}$, $\mathrm{Ce^{+3}}, \mathrm{La^{+3}}, \mathrm{Pm^{+3}}$ ions in increasing order of their ionic radii

(1) $\mathrm{Ce^{+3}} < \mathrm{Yb^{+3}} < \mathrm{Pm^{+3}} < \mathrm{La^{+3}}$

(2) $\mathrm{Yb^{+3}} < \mathrm{Pm^{+3}} < \mathrm{La^{+3}} < \mathrm{Ce^{+3}}$

(3) $\mathrm{Yb^{+3}} < \mathrm{Pm^{+3}} < \mathrm{Ce^{+3}} < \mathrm{La^{+3}}$

(4) $\mathrm{Pm^{+3}} < \mathrm{La^{+3}} < \mathrm{Ce^{+3}} < \mathrm{Yb^{+3}}$

Q36

For reactions $\mathrm{A} \rightarrow \mathrm{B}$ and $\mathrm{P} \rightarrow \mathrm{Q}$ Arrhenius constants are 10^8 and 10^{10} respectively. If $\mathrm{E_{A\rightarrow B}} = 600\ \mathrm{cal/mole}$ and $\mathrm{E_{P\rightarrow Q}} = 1200\ \mathrm{cal/mole}$, then find the temperature at which their rate constants are same.

(Given: $\mathrm{R} = 2\ \mathrm{cal/mole/K}$)

(1) $600\ \mathrm{K}$

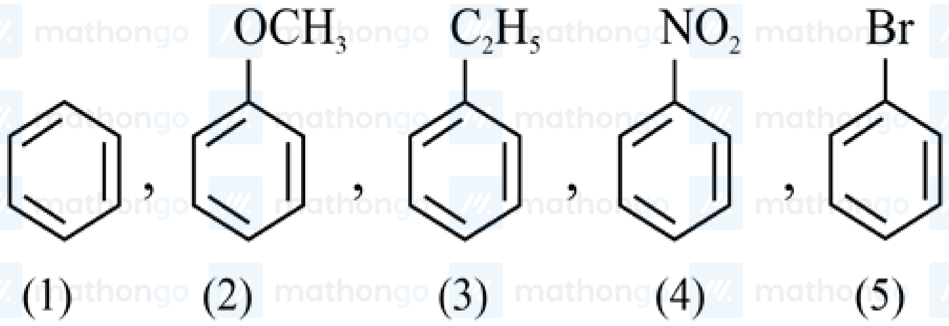
(2) $300 \times 4.606\ \mathrm{K}$

(3) $\frac{300}{4.606}\mathrm{K}$

(4) $\frac{4.606}{600}\mathrm{K}$

Q37

Give the order of decreasing reactivity towards an electrophile.



(1) $2 > 3 > 1 > 5 > 4$

(2) $3 > 1 > 2 > 5 > 4$

(3) $5 > 4 > 2 > 3 > 1$

(4) $1 > 5 > 2 > 3 > 4$

Q38

Among the following which one will have the largest $\mathrm{O} - \mathrm{O}$ bond length?

(1) KO_2

(2) O_2

(3) $\mathrm{O}_2^+[\mathrm{AsF}_6]^-$

(4) $K_2\mathrm{O}_2$

Q39

In the Kjeldahl's method for estimation of nitrogen present in a soil sample, ammonia evolved from 0.75 g of sample neutralized 10 mL of 1M H_2SO_4. The percentage of nitrogen in the soil is

(1) 37.33

(2) 43.33

(3) 45.33

(4) 35.33

Q40

A Buffer solution having pH 4.72 is prepared by mixing of 1 M NaOH and 1 M HCN . What is the ratio of volume of acid to base? $\left(pk_b \text{ of } CN^- = 9.28\right)$

(1) 1 : 1

(2) 1 : 2

(3) 2 : 1

(4) 3 : 1

Q41

Assertion (A): The denaturation of proteins can destroy all $1^\circ, 2^\circ$ and 3° protein structures.

Reason (R): Curdling of milk is due to denaturation of proteins.

The correct option among the following is

(1) (A) is true, (R) is true and (R) is the correct explanation for (A)

(2) (A) is true, (R) is true but (R) is not the correct explanation for (A)

(3) (A) is true but (R) is false

(4) (A) is false but (R) is true

Q42

All the elements of Group 15 form hydrides of the type EH_3. From the following given statements with respect to EH_3, select the incorrect one.

(1) Basicity as well as reducing strength is maximum for NH_3

(2) Standard enthalpy of formation is negative only for NH_3 while for others it is positive

(3) HEH bond angle follows the order:
$NH_3 > PH_3 > AsH_3 > SbH_3$

(4) Boiling point follows the order:
$PH_3 < AsH_3 < NH_3 < SbH_3$

Q43

It is an experimental fact that $\mathrm{dmg} + \mathrm{Ni(II)}$ salt $+ \mathrm{NH_4\ OH} \longrightarrow$ Red ppt Which of the following is wrong about this Red ppt.?

(1) It is non-ionic compound

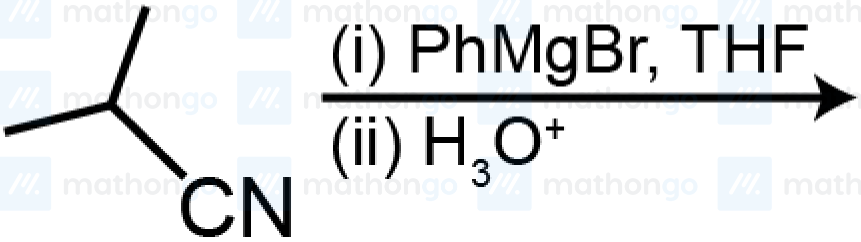
(2) It involves intra molecular H-bonding

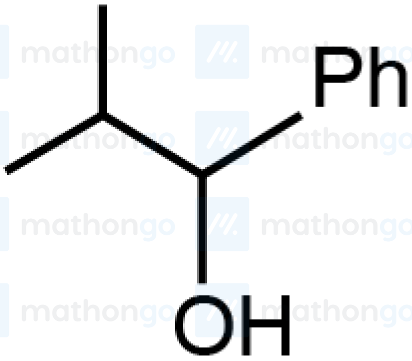
(3) $\mathrm{Ni(II)}$ is sp^3 hybridised

(4) It is a diamagnetic complex

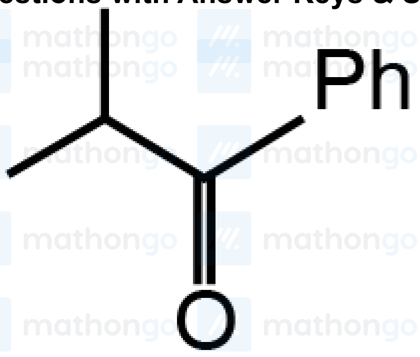
Q44

For the reaction below the structure of the product Q is





(1)



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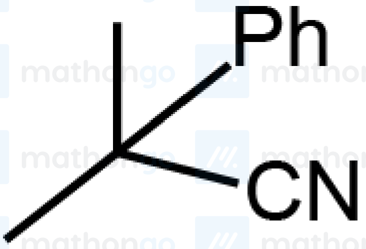

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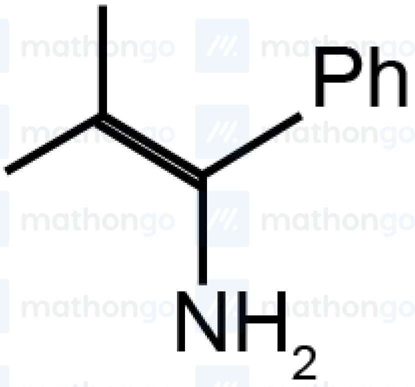


(4)

Q45

6 mol of a mixture of Mohr's salt and $Fe_2(SO_4)_3$ requires 500 ml of 1 M of $K_2Cr_2O_7$ for complete oxidation in acidic medium. The mole % of the Mohr's salt in the mixture is

(1) 75

(2) 50

(3) 60

(4) 25

Q46

In how many of the following species the central atoms have two lone pairs of electrons?

XeF_4 XeF_5^- F_2SeO_2
XeF_3^+ $XeOF_4$ $ClOF_3$
ICl_4^- SCl_2 OSF_4

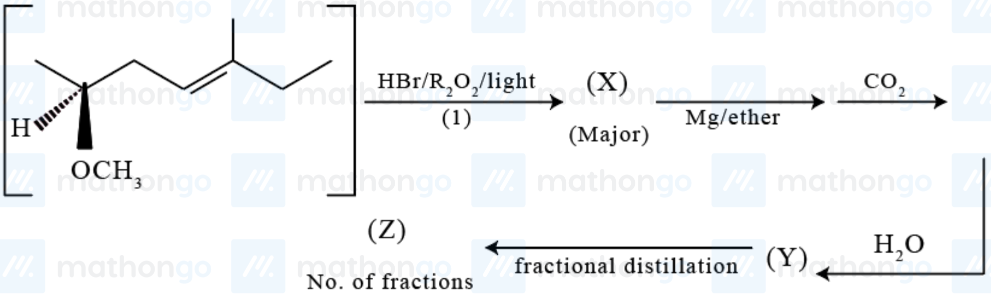
Q47

The work done in an open vessel at $300\ \mathrm{K}$, when $112\ \mathrm{g}$ iron reacts with dilute HCl to give FeCl_2 , is nearly W, find 5W. Mark answer in calories.

Q48

A 1 L solution of $CuSO_4$ was electrolysed till the pH of the solution become 1. A current of 0.965 A was passed through the solution for $x \times 10^y$sec with an efficiency of 20%. Report the value of $25y/x$ (x and y are smallest integers)

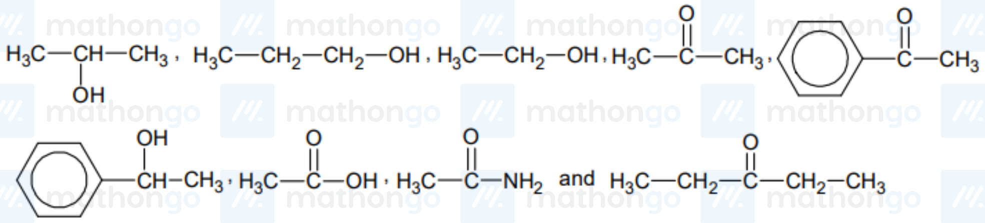
Q49



Find the value of (Z).

Q50

Among the following the total number of compounds which give positive iodoform test is/are:



Q51

The mean and variance of 20 observations are found to be 10 and 4 respectively. On rechecking, it was found that an observation 8 is incorrect. If the wrong observation is omitted, then the correct variance is

(1) 7

(2) $\frac{100}{19}$

(3) $\frac{1400}{361}$

(4) $\frac{1440}{361}$

Q52

The solution of differential equation $\left(2xy^4e^y + 2xy^3 + y\right)dx + \left(x^2y^4e^y - x^2y^2 - 3x\right)dy = 0$ is

(1) $x^2e^y + \frac{x^2}{y} + \frac{x}{y^3} = c$

(2) $x^2e^y - \frac{x^2}{y} + \frac{x}{y^3} = c$

(3) $x^2e^y + \frac{x^2}{y} - \frac{x}{y^3} = c$

(4) $x^2e^y - \frac{x^2}{y} - \frac{x}{y^3} = c$

Q53

Consider the real valued function $h : \{0, 1, 2 \ldots\ldots 100\} \rightarrow R$ such that $h(0) = 5, h(100) = 20$ and satisfying $h(p) = \frac{1}{2}\{h(p+1) + h(p-1)\}$ for every $p = 1, 2 \ldots .99$. Then the value of $h(1)$ is

(1) 5.15

(2) 5.5

(3) 6

(4) 6.15

Q54

If α and β are roots of $x^2 - x + 2 = 0$ and $S_n = \alpha^n + \beta^n, n \in N$, then value of $\frac{\sum_{n=1}^{5} S_n}{\sum_{n=1}^{4} \alpha^n + \sum_{n=1}^{4} \beta^n + 7}$ is

(1) 5

(2) 6

(3) 2.5

(4) 3

Q55

If $A=\begin{bmatrix} a & x & y \\ x & b & z \\ y & z & c \end{bmatrix}$, where $a, b, c, x, y, z \in \{1,2,3,4,5,6\}$ and a, b, c, x, y, z are distinct, then number of matrices in A with trace equal to 10 are: (where trace represents the sum of diagonal elements of a square matrix)

(1) 108

(2) 72

(3) 36

(4) 216

Q56

The area of the region bounded by the curves $y=9x^2$ and $y=5x^2+4$ (in sq units) is $\frac{K}{3}$, find K.

(1) 19

(2) 16

(3) 18

(4) 17

Q57

Suppose families always have one, two or three children, with probabilities $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{1}{4}$ respectively. Assume everyone eventually gets married and has children, the probability of a couple having exactly four grandchildren is

(1) $\frac{27}{128}$

(2) $\frac{37}{128}$

(3) $\frac{25}{128}$

(4) $\frac{20}{128}$

Q58

$\vec{a}=3\hat{i}+\hat{j}-\hat{k}, \vec{b}=\hat{i}-4\hat{j}+5\hat{k}, \vec{c}=4\hat{i}+5\hat{j}-\hat{k}$ are three vectors and a vector $\vec{r}$ is perpendicular to both the vectors $\vec{b}$ and $\vec{c}$. If $\vec{r}\cdot\vec{a}=9$, then $\vec{r}=$

(1) $3(\hat{i}-\hat{j}-\hat{k})$

(2) $3(\hat{i}-\hat{j}+\hat{k})$

(3) $9(\hat{i}-\hat{j}-\hat{k})$

(4) $9(\hat{i}-\hat{j}+\hat{k})$

Q59

Let the solution of the equation $\frac{dy}{dx}=y+\int_0^2 y dx$ is $y(x)$. If $y(0)=1$, then $y(2)=$

(1) $\frac{e^2+2}{4e^2-1}$

(2) $\frac{2e^2+1}{4-e^2}$

(3) $\frac{2e^2-1}{4e^2-1}$

(4) $\frac{e^2-2}{4-e^2}$

Q60

Let $f(x)=\begin{cases}4x-x^3+\ell n\left(b^2-3b+3\right), & 2\leq x<3\\ x-18 & x\geq 3\end{cases}$. Find all the possible real values of b such that $f(x)$ has the smallest value at $x=3$.

(1) $(-\infty,2]\cup[3,\infty)$

(2) $(-\infty,1]\cup[2,\infty)$

(3) $(1,2]$

(4) $(-\infty,2]$

Q61

If $\tan^{-1}\left(\frac{1}{2}\right)+\tan^{-1}\left(\frac{2}{3x}\right)+\tan^{-1}\left(\frac{3}{4}\right)=\frac{\pi}{2}$, then the value of $\tan\left(\pi-2\tan^{-1}x\right)$ is :

(1) $\frac{24}{7}$

(2) $\frac{7}{24}$

(3) $\frac{25}{7}$

(4) $\frac{7}{25}$

Q62

If z be a complex number satisfying $|z|^2 + 2(z + \bar{z}) - 5 = 0$, then complex number $z + 3 + 2i$ will lie on $\left(i = \sqrt{-1}\right)$

(1) Circle with centre $1 - 2i$ and radius 4

(2) Circle with centre $1 + 2i$ and radius 4

(3) Circle with centre $1 + 2i$ and radius 3

(4) Circle with centre $1 - 2i$ and radius 3

Q63

Equation of the line of shortest distance between the lines $\frac{x}{2} = \frac{y}{-3} = \frac{z}{1}$ and $\frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+2}{2}$ is -

(1) $3(x - 21) = (3y - 92) = (3z - 32)$

(2) $3x - 62 = 3y - 93 = 3z + 31$

(3) $\frac{(x-21)}{3} = \frac{\left(y + \frac{92}{3}\right)}{3} = \frac{\left(z - \frac{32}{3}\right)}{3}$

(4) $x - \frac{62}{3} = y + 31 = \left(z + \frac{31}{3}\right)$

Q64

If system of equations
$x + (\sin\alpha)y + \left(\sin^2\alpha\right)z = 0$
$x + (\cos\alpha)y + \left(\cos^2\alpha\right)z = 0$
$x + (\sin 2\alpha)y + \left(\sin^2 2\alpha\right)z = 0$
has non trivial solutions, then number of distinct values of α (where $\alpha \in [0, \pi]$), is

(1) 9

(2) 6

(3) 8

(4) 7

Q65

O is the vertex of the parabola $y^2 = 4ax$ and L is the upper end of the latus rectum. If LH is drawn perpendicular to OL meeting OX in H, then the length of the double ordinate through H is

(1) $4\sqrt{5}$

(2) $4\sqrt{5}\,a$

(3) $3\sqrt{5}\,a$

(4) $2\sqrt{5}\,a$

Q66

The direction cosines of two lines are given by $2\ell+\lambda \mathrm{m}+n=0$ and $\mathrm{mn}+\mathrm{n}\ell-5\ell \mathrm{m}=0$. Find value of λ, if the lines are perpendicular.

(1) $\frac{1}{3}$

(2) $\frac{2}{9}$

(3) $\frac{2}{3}$

(4) None of these

Q67

If $f(x)$ be a function such that $f(x+1)=\frac{f(x)-1}{f(x)+1}, \forall x \in \mathrm{N}$ and $f(1)=2$ then $f(999)$ is -

(1) -3

(2) 2

(3) $\frac{1}{3}$

(4) $-\frac{1}{2}$

Q68

Let $f(x)=\lim_{n \rightarrow \infty} \tan^{-1}\left\{4 n^2\left(1-\cos \frac{x}{n}\right)\right\}$ and $g(x)=\lim_{n \rightarrow \infty} \frac{n^2}{2} \ln \cos \left(\frac{2 x}{n}\right)$, then $\lim_{x \rightarrow 0} \frac{f(x)+2 g(x)}{x^6}=$

(1) $\frac{4}{3}$

(2) $-\frac{4}{3}$

(3) $\frac{8}{3}$

(4) $-\frac{8}{3}$

Q69

If $\int \frac{x^{pq-p-1}}{(x^p+1)^q}\,dx = \frac{2\left(1+x^{-p}\right)^{1-q}}{\lambda p(q-1)} + \mathrm{c}\ (p, q \in N - \{1\})$, then the value of λ is (here, c is an arbitrary constant)

(1) 3

(2) 4

(3) 2

(4) 6

Q70

Consider $\triangle ABC$ whose vertices are $A \equiv (m, n), B \equiv (1, 2), C \equiv (2, 3)$ and vertex 'A' lies on the line $2x - y + 3 = 0$, where $m, n \in N$ with $m + n > 10$. Let area of $\triangle ABC$ be S such that $[S] = 2$, where $[x]$ denotes greatest integer less than or equal to x. If the equation of side AC of ΔABC is $ax + by = 9$, then $(a + b)$ equals

(1) 4

(2) 15

(3) 5

(4) 11

Q71

If number of arrangements of letters of the word "DHARAMSHALA" taken all at a time so that no two alike letters appear together is $\left(4^a . 5^b \cdot 6^c \cdot 7^d\right)$, (where $a, b, c, d \in N$), then $a + b + c + d$ is equal to

Q72

Let $\vec{x} = \hat{i} + 3\hat{j} - 2\hat{k}, \vec{y} = 2\hat{i} + 4\hat{j} + \hat{k}$ and a vector $\vec{z}$ satisfying $\vec{x} \times \vec{z} = \vec{x} \times \vec{y}$ and $\vec{z} \cdot \vec{x} = 0$. Then $[|\vec{z}|]$ is, (where [.] denotes greatest integer function)

Q73

The number of points where $f(x) = |x + [x]| - 3[2x] + 4[3x]$ is discontinuous in $[-1, 1]$, is:
[Note: $[k]$ denotes greatest integer less than or equal to k.]

Q74

The coefficient of x^4 appearing in the expansion of $\left(1+x^2\right)^{10}(1-x)^6\left(1+x^3\right)^8(1+x)^6$ is

Q75

If $\lim_{n\to\infty}\int_{\frac{-1}{\sqrt[3]{n}}}^{\frac{1}{\sqrt[3]{n}}} x\ln\left(1+e^x+e^{2x}+e^{3x}+\ldots\ldots.e^{2nx}\right)dx=\prod_{k=2}^{m}\left(1-\frac{1}{k^2}\right)$ then find the value of m.

ANSWER KEYS

1. (4)
2. (3, 4)
3. (3)
4. (3)
5. (1)
6. (3)
7. (1)
8. (1)
9. (2)
10. (1)
11. (2)
12. (3)
13. (1)
14. (3)
15. (2)
16. (4)
17. (3)
18. (2)
19. (4)
20. (1)
21. (20)
22. (3)
23. (8)
24. (5)
25. (7)
26. (4)
27. (1)
28. (4)
29. (3)
30. (4)
31. (2)
32. (2)
33. (4)
34. (3)
35. (3)
36. (3)
37. (1)
38. (4)
39. (1)
40. (3)
41. (4)
42. (1)
43. (3)
44. (2)
45. (2)
46. (5)
47. (6000)
48. (20)
49. (4)
50. (5)
51. (4)
52. (1)
53. (1)
54. (1)
55. (1)
56. (2)
57. (1)
58. (1)
59. (2)
60. (2)
61. (1)
62. (3)
63. (3)
64. (4)
65. (2)
66. (2)
67. (4)
68. (4)
69. (3)
70. (3)
71. (7)
72. (3)
73. (7)
74. (0)
75. (3)

1. **(4)** Initial resistance,

$R_1 = 20\Omega \Rightarrow \frac{\rho l_1}{A_1} = 20$ ...(i)

Now, $\quad l_2 = 3l_1$

$\because$ Volume remains same.

$\therefore \quad V_1 = V_2 \Rightarrow A_1 l_1 = A_2 l_2$

$A_1 l_1 = A_2 \times 3l_1 \Rightarrow A_2 = \frac{A_1}{3}$

So, final resistance,

$$R_2 = \frac{\rho l_2}{A_2} = \frac{\rho \times 3l_1}{\left(\frac{A_1}{3}\right)} = \frac{9\rho l_1}{A_1} = 9 \times 20\Omega \quad \text{[by Eq. (i)]}$$

$$= 180\Omega$$

2. $\frac{2\pi}{\lambda}x = \frac{2\pi}{\mathrm{L}}x$

$\therefore \lambda = \mathrm{L} = 1.2\ \mathrm{m}$

(3, 4) at $x = 0, x = \mathrm{L}, y = 0$

$\mathrm{v} = \frac{\mathrm{v}}{\lambda} = \frac{300}{1.2} = 250\ \mathrm{Hz}$

Wavelength of the Wave:

- For a standing wave, $L = n\frac{\lambda}{2}$, where $n = 1, 2, 3, \ldots$ (the harmonic number).

- The possible wavelength for $\boldsymbol{n} = 2$ is:

$\lambda = L = 1.2\ \mathrm{m}$

Frequency of the Fundamental Mode:

- In the fundamental mode ($n=1$), the wavelength is:

$\lambda_1 = 2L = 2\times 1.2 = 2.4\ \mathrm{m}$

- The frequency f_1 is:

$f_1 = \frac{v}{\lambda_1} = \frac{300}{2.4} = 125\ \mathrm{Hz}$

Frequency of the Wave Described in the Equation:

- The time-dependent term in the equation is $\sin\left(\frac{2\pi t}{T}+\frac{\pi}{4}\right)$, which implies the period $T = 1/f$.

- From the equation, $T = \frac{1}{137.5\ \mathrm{Hz}}$.

(A) : "The pipe is closed at both ends."

This is correct because the standing wave equation suggests nodes at both ends, consistent with a pipe closed at both ends.

(B) : "The wavelength of the wave could be 1.2 m."

This is correct because for the second harmonic $(n=2)$, $\lambda = L = 1.2\ \mathrm{m}$.

(C) : "There could be a node at $x=0$ and an antinode at $x=L/2$."

This is incorrect because equation show node at $x=L/2$

(D) : "The frequency of the fundamental mode of vibrations is 137.5 Hz."

This is incorrect because the fundamental mode frequency is $f_1 = 125\ \mathrm{Hz}$, not 137.5 Hz.

3. (3)

As the process is sudden, so it must be an adiabatic process.

And for adiabatic process, equation of state is,

$P_1{V_1}^{\gamma} = P_2{V_2}^{\gamma}$

$\Rightarrow P_2 = \frac{P_1{V_1}^{\gamma}}{{V_2}^{\gamma}}$

Substituting all the given values, we have,

$\Rightarrow P_2 = \left(10^6\right)\left(\frac{300}{150}\right)^{1.4} = 2.6\times 10^6\ \text{dyne}\ \text{cm}^{-2}$

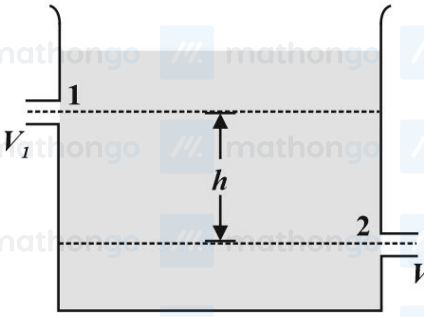
4. (3)

Rate of change of momentum= $\frac{\mathrm{dp}}{\mathrm{dt}}$

$$F = F_Q - F_P = \frac{dp_Q}{dt} - \frac{dp_P}{dt} = \left(\frac{dm}{dt}\right)_Q \times V_Q - \left(\frac{dm}{\mathrm{dt}}\right)_P \times V_P$$

$$= A\rho v_Q \times v_Q - A\rho v_P \times v_P$$

$$= A\rho\left({v_Q}^2 - {v_P}^2\right) \quad \text{...(i)}$$

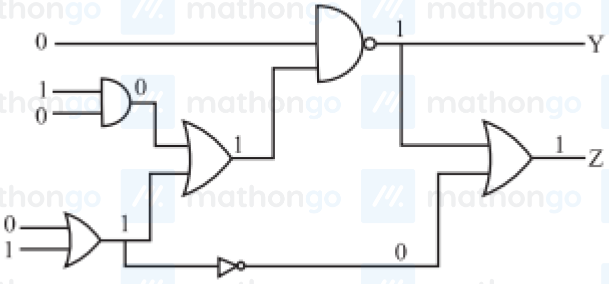


$P_P+\frac{1}{2}\rho v_P^2+\rho gh=P_Q+\frac{1}{2}\rho v_Q^2+0 \quad (\because P_P=P_Q)$

$\Rightarrow \frac{1}{2}\rho\left(v_Q^2-v_P^2\right)=\rho gh$

$\therefore F=2A\rho gh$ (from (i))

5.



(1)

So, $Y=1$ & $Z=1$

6. **(3)**

$\mathrm{I_{remaining}}=\mathrm{I_{total}}-\mathrm{I_{removed}}$

$\mathrm{I_{remaining}}=\mathrm{I_{total}}-4\mathrm{I_{each\ disc}}$

$\mathrm{I_{remaining}}=\mathrm{I}=\mathrm{I_{total}}-4\times\left(\mathrm{I_{disc}}+\mathrm{M_{disc}}\left(\sqrt{2}\mathrm{R}\right)^2\right)$ (From parallel axis theorem)

$\mathrm{I}=\frac{1}{12}\mathrm{M}\left(32\mathrm{R}^2\right)-4\times\left(\frac{1}{2}\times\frac{\pi\mathrm{M}}{16}\times\mathrm{R}^2+\frac{\pi\mathrm{M}}{16}\times2\mathrm{R}^2\right) \qquad \left(\because \mathrm{M_{disc}}=\frac{\pi\mathrm{M}}{16}\right)$

$\mathrm{I}=\frac{8}{3}\mathrm{MR}^2-4\times\frac{5}{2}\times\frac{\pi\mathrm{M}}{16}\times\mathrm{R}^2=\mathrm{MR}^2\left(\frac{8}{3}-\frac{20\pi}{32}\right)$

$\mathrm{I}=\left(\frac{8}{3}-\frac{10\pi}{16}\right)\mathrm{MR}^2$

7. **(1)** Stopping potentials for b and a are same

$\therefore \quad f_a=f_b$

and saturation current for b and a are different

$\therefore \quad I_b\neq I_a$

8. **(1)**

Heat loss will always be equal to heat gain.

As per 1stcondition,

$100\times\mathrm{S_A}\times(100-90)=50\times\mathrm{S_B}\times(90-75)$ ___(i)

As per 2nd condition,

$100\times\mathrm{S_A}(100-\theta)=50\times\mathrm{S_B}(\theta-50)$ ___(ii)

Dividing (ii) by (i), we get

$\frac{100-\theta}{100-90}=\frac{\theta-50}{90-75}$

$300-3\theta=2\theta-100$

$\theta=80^{\circ}\mathrm{C}$

9. **(2)** Magnetic field due to the circular segment $=\frac{3}{4}\cdot\frac{\mu_0 i}{2a}$

Due to one straight wire segment $=\frac{\mu_0 i}{4\pi b}\left(\sin 45^{\circ}+\sin 0^{\circ}\right)=\frac{\mu_0 i}{4\sqrt{2}\pi b}$

Net field

$=\frac{3\mu_0 i}{8a}+2\times\frac{\mu_0 i}{4\sqrt{2}\pi b}=\frac{\mu_0 i}{4\pi}\left(\frac{3\pi}{2\mathrm{a}}+\frac{\sqrt{2}}{\mathrm{b}}\right)$

10. **(1)** For real inverted image formed by concave mirror.

$\mathrm{v}=-\mathrm{ve},\ \ \mathrm{u}=-\mathrm{ve},\ \mathrm{f}=-\mathrm{ve}$

$\Rightarrow\ \ \frac{\mathrm{u}}{\mathrm{f}}\ \&\ \frac{\mathrm{v}}{\mathrm{f}}$ are positive

So graph show be in 1st qudarant

and $\frac{1}{\mathrm{v}}+\frac{1}{\mathrm{u}}=\frac{1}{\mathrm{f}}$

$\Rightarrow\ \ \frac{\mathrm{f}}{\mathrm{v}}+\frac{\mathrm{f}}{\mathrm{u}}=1$

This graph can also be realized by Newtons formula $\mathrm{x}_1\mathrm{x}_2=\mathrm{f}^2$ where x_1, and x_2 are distance from focus so graph will be rectangular hyperbola

$\Rightarrow$ (1) is right answer.

11. **(2)** (A) X-rays → (R) Crystal structure study

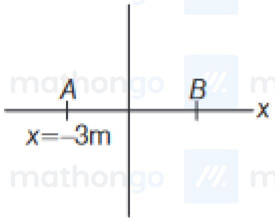
(B) uv- rays → (Q) Finger prints in forensic labs

(C) Radio waves (S) TV communication system

(D) IR-rays (P) Remote switches

12. **(3)** Potential energy,

$U=2-20x+5x^2 J$



When particle gains whole of potential energy in the form of kinetic energy at $x=-3$ m, then it will travel maximum distance till whole of its kinetic energy becomes zero.

i.e., $\quad K=U=0$

$\Rightarrow\quad 2-20x+5x^2=0$

$\quad 5x^2-20x+2=0$

$\therefore\quad x=\frac{-(-20)\pm\sqrt{(-20)^2-4\times5\times2}}{2\times5}$

$\quad=\frac{20\pm\sqrt{360}}{10}=\frac{20\pm18.97}{10}$

$\quad x=2\pm1.9$

For maximum value of x, taking + ve sign

$$x = 2 + 1.9 = 3.9$$

$$\therefore \text{ Total distance } = |-3| + 3.9$$
$$= 6.9\ \mathrm{m} \simeq 7\ \mathrm{m}$$

13. **(1)** We know that, fring width

$\beta = \frac{D\lambda}{d}$ ....(i)

When distance slits is increased 10 times and distance between between the source and screen is halved, then new fringe width,

$\beta' = \frac{D'\lambda}{d'}$

$= \frac{D\lambda}{2\times10\times d}$

$= \frac{1}{20}\cdot\frac{D\lambda}{d}$

$= \frac{\beta}{20}$ [from Equation (i)]

14. **(3)** The current at time t is given by

$$i = i_0\left(1 - \mathrm{e}^{-t/\tau}\right)$$

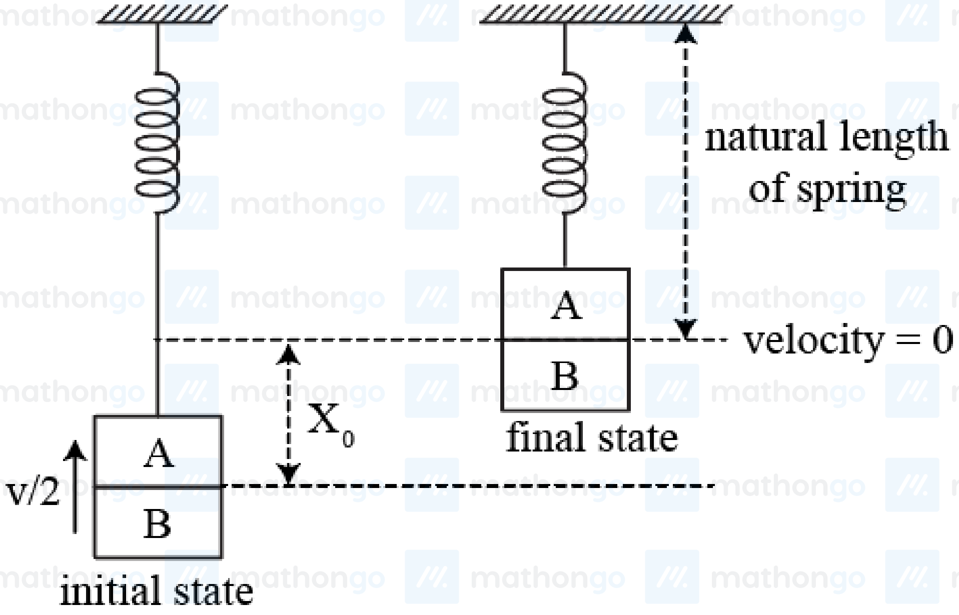
Here, $i_0 = \frac{E}{R}$ and $\tau = \frac{L}{R}$

$$\therefore\ q = \int_0^\tau i\mathrm{d}t = \int_0^\tau i_0\left(1 - \mathrm{e}^{-t/\tau}\right)\mathrm{d}t$$

$$= \frac{i_0\tau}{e} = \frac{\left(\frac{E}{R}\right)\left(\frac{L}{R}\right)}{e}$$

$$= \frac{EL}{eR^2}$$

15. **(2)** The initial extension in spring is $x_0 = \frac{\mathrm{mg}}{k}$. Just after collision of B with A the speed of combined mass is $\frac{\mathrm{v}}{2}$. For the spring to just attain natural length the combined mass must rise up by $x_0 = \frac{\mathrm{mg}}{k}$ and comes to rest.



Applying conservation of energy between initial and final states

$\frac{1}{2}2\,\mathrm{m}\left[\frac{\mathrm{v}}{2}\right]^2+\frac{1}{2}k\left[\frac{\mathrm{mg}}{k}\right]^2=2\mathrm{mg}\left[\frac{\mathrm{mg}}{k}\right]$

Solving we get $\mathrm{v}=\sqrt{\frac{6\mathrm{mg}^2}{k}}$.

16. **(4)** Given, $x=0.20\text{ m},\ y=0.20\text{ m},\ u=1.8\text{ m s}^{-1}$

Let the ball strike the nth step of stairs,

Vertical distance travelled $=$ ny

Using equation of motion in y-direction

$s=ut+\frac{1}{2}at^2$

$\Longrightarrow -ny=0\text{-}\frac{1}{2}gt^2$ ...(1)

Horizontal distance travelled $=\ nx$

$\Longrightarrow \mathrm{nx}=ut$

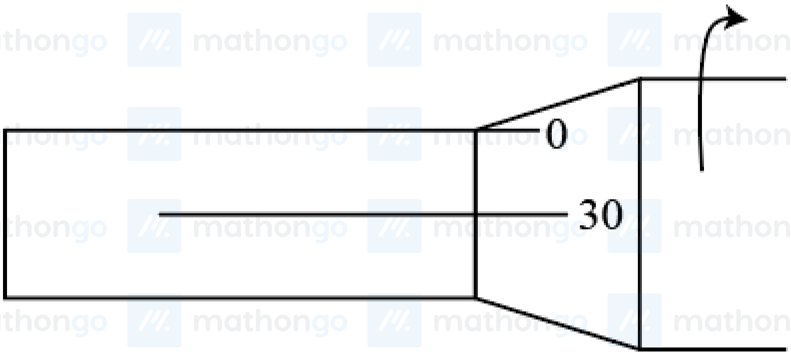
$\Longrightarrow t=\frac{nx}{u}$ ...(2)

using (1) and (2)

$ny=\frac{1}{2}g\left(\frac{nx}{u}\right)^2$

or $n=\frac{2u^2}{g}\frac{y}{x^2}=3.3\Longrightarrow 4^{th}\ stair$

17.



(3)

MSD (pitch)$=\frac{2}{4}=0.5\text{ mm}, n=50\text{div}$

$L\cdot C=\frac{0.5}{50}=0.01\text{ mm}$

-ve zero error $=MSR+CSR$

$=-0.5+30\times 0.01$

$=-0.5+0.3$

$=-0.2\text{ mm}$

Reading $=2\times 0.5+20\times 0.01$

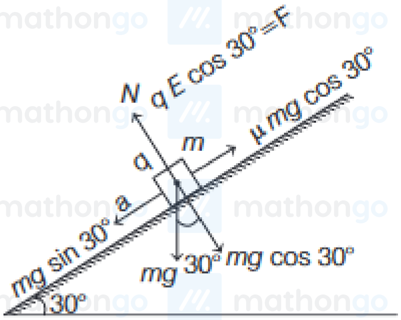
$=1+0.2$

$=1.2\text{ mm}$

final Ans $=1.2-(-0.2)$

$=1.4\text{ mm.}$

18. **(2)** According to the question, an inclined plane is making an angle of 30° with the horizontal, placed in a uniform electric field of 100 nm^{-1}. It can be such in the figure that a block of mass m is sliding down from rest at height h .



From the above diagram, the total force F acting along inclined plane.

From fig,

$mg\sin 30^\circ - \mu mg\cos 30^\circ - qE\cos 30^\circ = ma = F$

Given,

$\mu = 0.2, m = 1\text{ kg}, , q = 0.01\text{C}$ and $h = 1\text{ m}$

Putting these values, we get

$$10 \times \frac{1}{2} - 0.2 \times 10 \times \frac{\sqrt{3}}{2} - 0.01 \times 100 \times \frac{\sqrt{3}}{2} = a$$

$a = 5 - \sqrt{3} - 0.5\sqrt{3} \approx 2.4\text{ ms}^{-2}$

Hence, the acceleration of the block is nearly, 2.4 ms^{-2}.

19. (4)

The internal energy of n moles of a gas is $U = \frac{1}{2}nFRT$

where F = number of degrees of freedom.

The internal energy of 2 moles of oxygen at temperature T is

$U_1 = \frac{1}{2} \times 2 \times 5RT = 5RT$ (F = 5 for oxygen molecule)

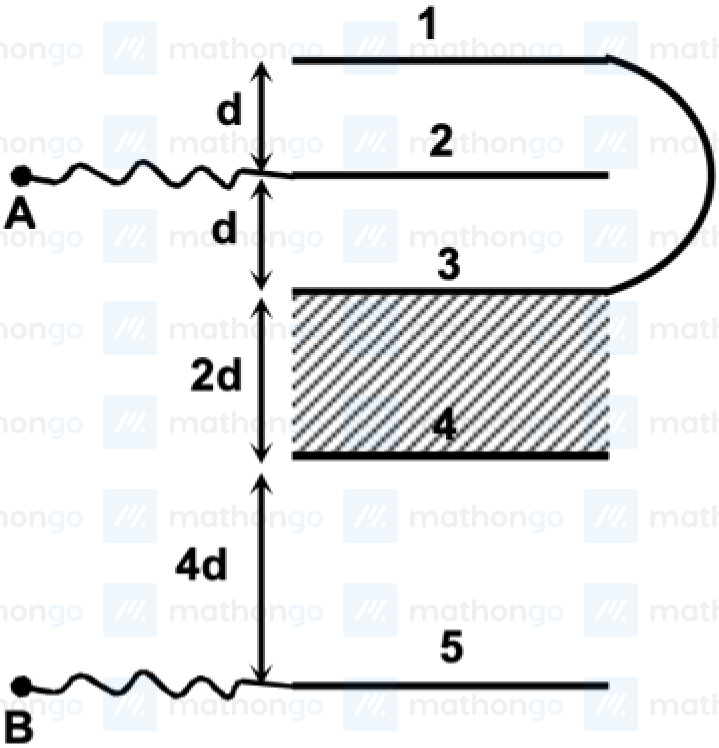
The total internal energy of 4 moles of argon at temperature T is

$U_2 = \frac{1}{2} \times 4 \times 3RT = 6RT$ (F = 3 for argon molecule)

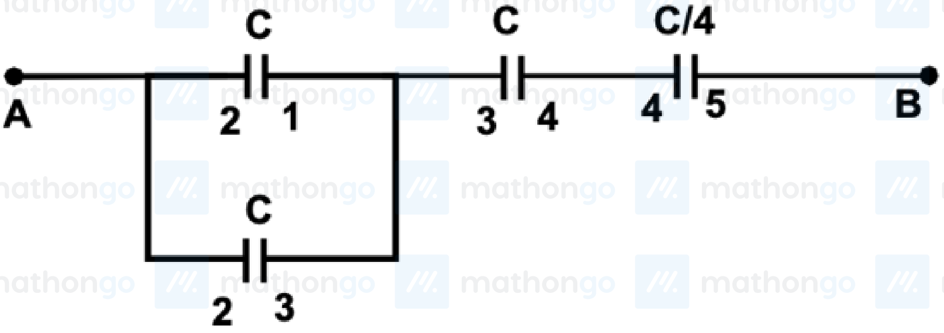
Total internal energy $= U_1 + U_2 = 11RT$

$\Rightarrow x = 11$

20.



(1)



$$C=\frac{\varepsilon_0 S}{d}=1\mu\,\mathrm{F}$$

$$\frac{1}{\mathrm{C_{AB}}}=\frac{1}{2}+1+\frac{4}{1}=\frac{11}{2}$$

$$\therefore C_{AB}=\frac{2}{11}\mu\,\mathrm{F}$$

21. (20) The balance condition of a meter bridge experiment

$\frac{R}{S}=\frac{l_1}{(100-l_1)}$

Here, $R=R_1,\ S=R_2$

$\therefore\ \frac{R_1}{R_2}=\frac{l_1}{(100-l_1)}$

case-I

$\frac{R_1+10}{R_2}=\frac{50}{50}$ ...(i)

$\Rightarrow \quad R_1 + 10 = R_2$

case-II

$\frac{R_1}{R_2} = \frac{40}{60}$

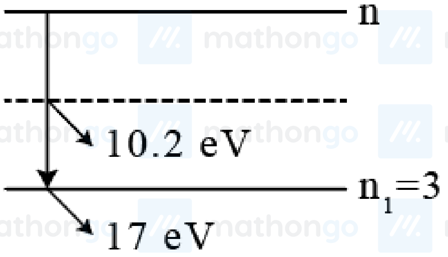
$\Rightarrow \quad R_2 = \frac{60}{40} R_1 \qquad$ ...(ii)

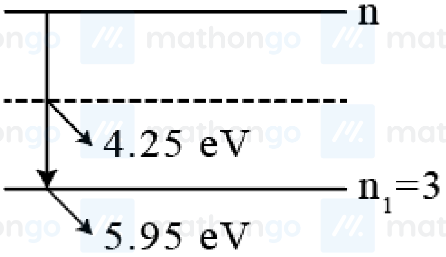
So, Eqs. (i) and (ii) give

$R_1 + 10 = \frac{60}{40} R_1$

$\Rightarrow R_1 = 20\ \Omega$

22.



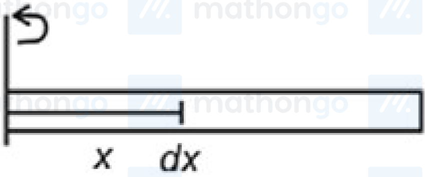


(3)

$10.2 + 17 = 13.6 \times \mathrm{Z}^2\left(\frac{1}{2^2} - \frac{1}{\mathrm{n}^2}\right); \qquad 4.25 + 5.95 = 13.6 \times \mathrm{Z}^2\left(\frac{1}{3^2} - \frac{1}{\mathrm{n}^2}\right)$

Solving the above two equation we get, Z = 3 and n = 6.

23.



(8)

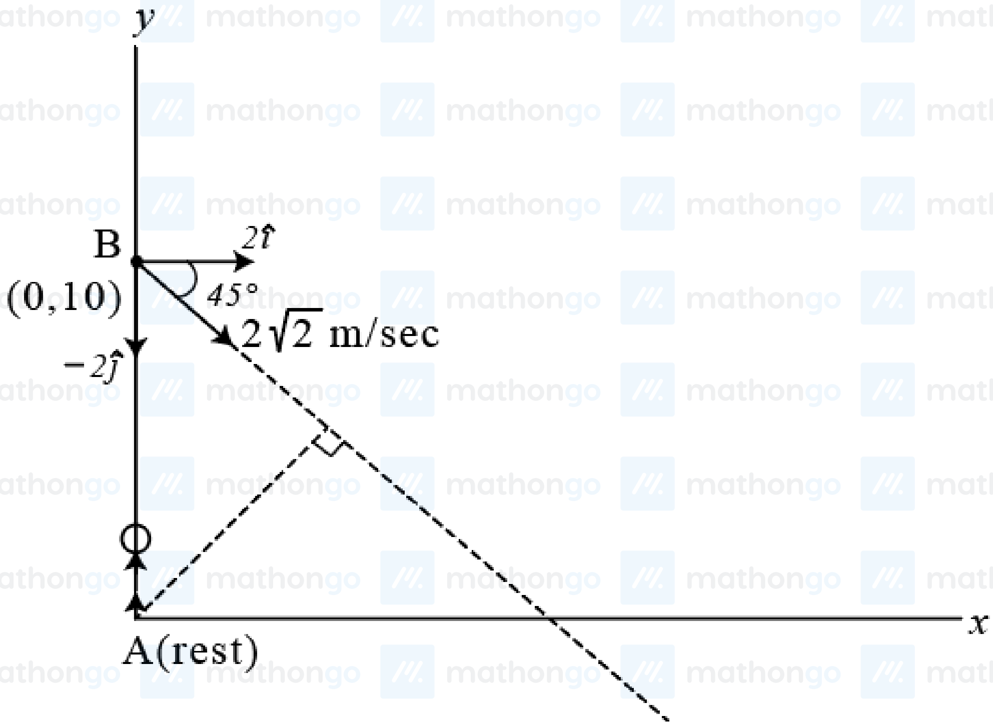
$dq = \lambda_0 x dx \Rightarrow \ i = \frac{\omega\ \lambda_0 x dx}{2\pi}$

$dm = \frac{\omega \lambda_0 x dx}{2\pi}\ \pi x^2 \Rightarrow m = \int dm = \int \frac{\omega\ \lambda_0}{2} x^3 dx$

$\therefore \quad m = \frac{\omega \lambda_0 L^4}{8}$

$n\ = 8$

24.



(5)

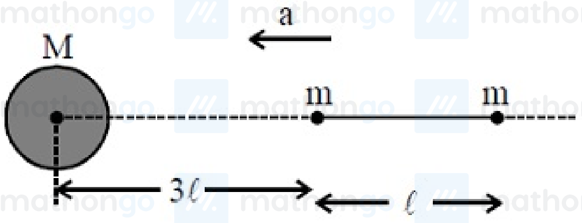
$$\vec{V}_{B,A} = \vec{V}_B - \overrightarrow{V_A}$$

$$= 2\hat{i} - 2\hat{j}$$

$$t = \frac{10/\sqrt{2}}{2\sqrt{2}} = 2.5\text{sec.}$$

25. **(7)** Due to gravitational interaction connected masses have some acceleration.

Let both small masses are moving with acceleration 'a' towards larger mass M



Force equation for mass nearer to a larger mass

$\frac{GMm}{(3l)^2} - \frac{Gm^2}{l^2} = ma$ ...(i)

Force equation for mass away from a larger mass

$\frac{GMm}{(4l)^2} + \frac{Gm^2}{l^2} = ma$ ...(ii)

From equation (i) & (ii)

$\frac{GM}{9l^2} - \frac{Gm}{l^2} = \frac{GM}{16l^2} + \frac{Gm}{l^2}$

$\Rightarrow \frac{M}{9} - \frac{M}{16} = m + m$

$\frac{7M}{144} = 2m$

$\Rightarrow m = \frac{7M}{288} = k\left(\frac{M}{288}\right)$

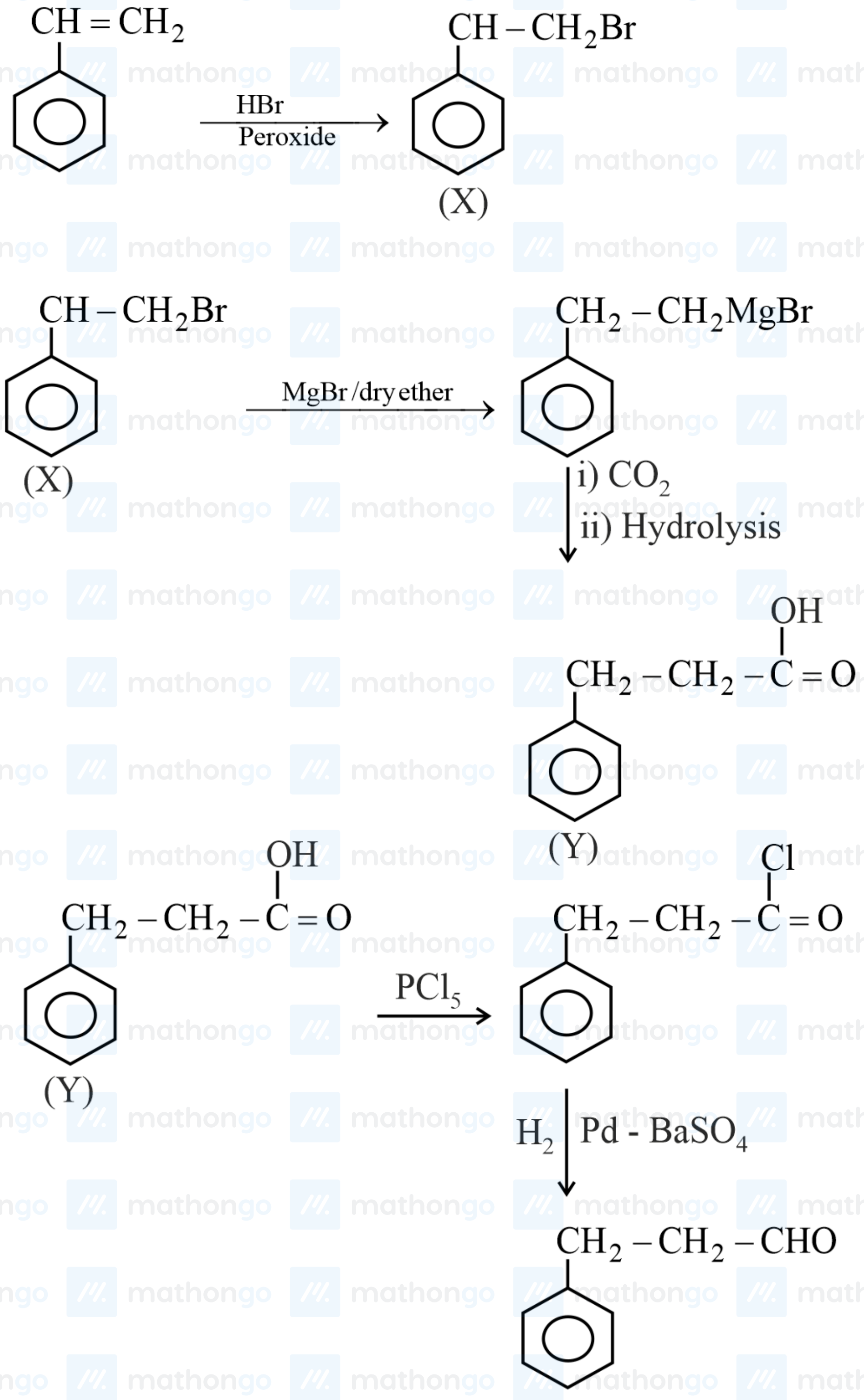
$\Rightarrow k = 7$

26. **(4)** n -Hexane +n -Heptane → Ideal solution

Benzene + Toluene → Ideal solution

CS_2+ Acetone → Non-ideal with positive deviation

27. **(1)**



First step of the reaction involves free radical addition of HBr to styrene in presence of peroxide to form 1-bromo-2-phenyl ethane(X)

1-bromo-2-phenyl ethane on reaction with Mg in presence of dry ether forms a grignard reagent,Which reacts with CO_2 by nucleophilic addition mechansim followed by hydrolysis to form 3-phenyl propanoic acid(Y).

3-phenyl propanoic acid(Y) reacts with PCl_5 to form 3-phenyl propanoyl chloride.

3-phenyl propanoyl chloride undergoes rosenmund reduction in presence of $Pd - BaSO_4$ to form 3-phenyl propan-1-al.

Hence Z is 3-phenyl propan-1-al

28. **(4)** pH of aqueous solution of salt of weak acid and weak base is given by $pH = 7 + \frac{1}{2}[pK_a - pK_b]$

CH_3COONa :

- Salt of a weak acid (CH_3COOH) and strong base ($NaOH$).
- pH depends on concentration (basic nature).

$C_6H_5NH_3Cl$:

- Salt of a weak base ($C_6H_5NH_2$) and strong acid (HCl).
- pH depends on concentration (acidic nature).

$PbCl_2$:

- Salt of a strong acid (HCl) and a slightly soluble base.
- Does not have consistent pH behavior.

CH_3COONH_4 :

- Salt of a weak acid (CH_3COOH) and a weak base (NH_3).
- pH is independent of concentration because it depends only on the ratio of K_a and K_b.

29. **(3)** $NH_4Cl +$ Nesseler 's reagent $\longrightarrow$ Brown colour of iodide million's base.

A : $FeCl_3 + KSCN \rightarrow$ Red colour. This forms $[Fe(SCN)]^{2+}$, which gives a blood-red colour. Correct.

B : $KI + PbCl_2 \rightarrow$ Yellow ppt. This forms PbI_2, a yellow precipitate. Correct.

C : NH_4Cl+ Nessler's reagent $\rightarrow$ Blue colour. This is incorrect as Nessler's reagent reacts with ammonium ions to produce a brown precipitate or yellow colour, not blue.

D : $DMG + Ni^{i+} + NH_4OH \rightarrow$ Scarlet red ppt. This forms $[Ni(DMG)_2]$, a scarlet red precipitate. Correct.

30. **(4)** Energy of e^-ejected from He^+ion

$= Ep - i \cdot E \cdot He^+$

$= (67.15 - 54.4)eV = 12.75eV$

Let $e^-$of H-atom goes to n^{th} orbit after being stroken by $e^-$of He^+ion then

$12.75 = E_n - E_1$

$$= -13.6 \times \frac{1}{n^2} + 13.6 = 13.6\left(1 - \frac{1}{n^2}\right)$$

$$\Rightarrow 1 - \frac{1}{n^2} = \frac{12.75}{13.60}$$

$$\Rightarrow \frac{1}{n^2} = 1 - \frac{1275}{1360} = \frac{85}{1360}$$

$$\Rightarrow n^2 = \frac{1360}{85} = 16 \Rightarrow n = 4$$

So no. of diff. spectral line obtained by H-atom

$= \frac{n(n-1)}{2} = \frac{4\times3}{2} = 6$

31. **(2)** Based on the total number electrons we can identify the atomic number of element, group number and period number in the periodic table.

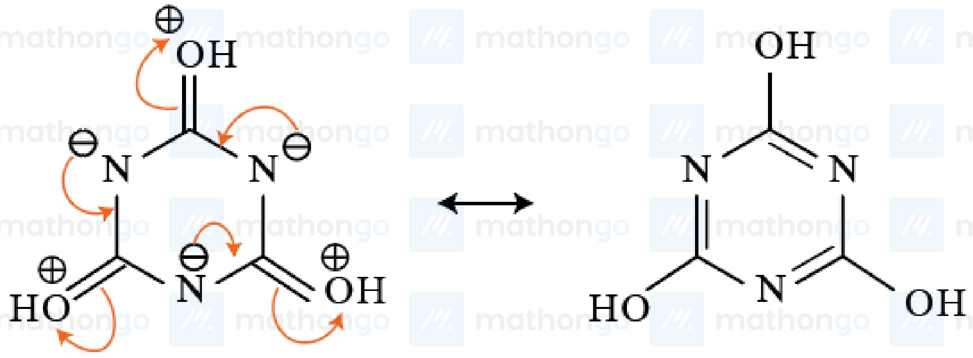
The electronic configuration $1 s^2 2 s^2 2p^5$ represents the element fluorine. Fluorine is the most electronegative element in the periodic table, and it belongs to 2nd period.

The electronic configuration $1 s^2 2 s^2 2p^3$ represents the element nitrogen. It belongs to 2nd period and 15th group in the periodic table.

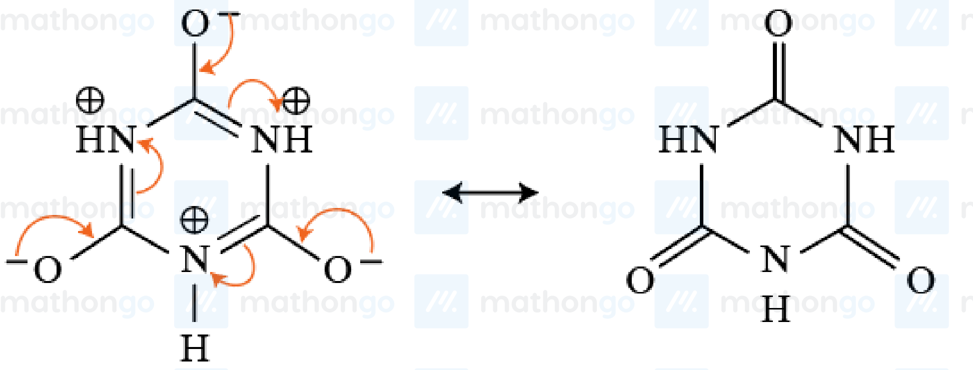
The electronic configuration $1 s^2 2 s^2 2p^6 3 s^2 3p^6 3 d^8 4 s^2$ represents the element nickel. It is a d-block element.

The electronic configuration $1 s^2 2 s^2 2p^6 3 s^2 3p^6$ represents the element argon. It is an element from 18th group.

32. **(2)** R and S, P and Q are resonating structures while P and R are tautomers structures.



Q P



S R

33. **(4)** This compound can be identified and named as follows

$Cr(H_2O)_6Br_n$

As $(\mu_{complex})_{spin} = 3.8 \text{ B.M.} = \sqrt{n(n+2)}$

On solving $n = 3$

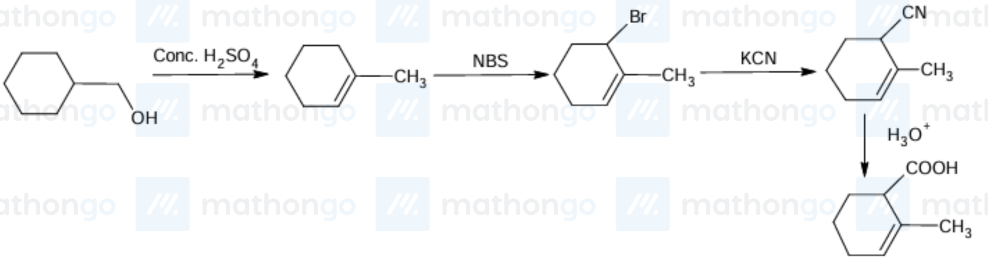
Hence the complex is $[Cr(H_2O)_6]\, Br_3$

oxidation number of $Cr = +3$.

As compound also shows geometrical isomerism so it will be $\left[Cr(H_2O)_4Br_2\right]$ $Br.2H_2O$

It is named as → Tetraaquadibromido chromium (III) bromide dihydrate

34.



(3)

35. **(3)** Due to Lanthanoid contraction their is greater decrease in ionic radii of elements in lanthanide series because of poor shielding of nuclear charge by 4f electrons, hence the order will be $Yb^{+3} < Pm^{3+} < Ce^{+3} < La^{3+}$

36. **(3)** $A_1 e^{-Ea_1/RT} = A_2 e^{-Ea_2/RT}$

$\frac{A_2}{A_1} = e^{(Ea_2 - Ea_1)/RT}$

$10^2 = \text{Exp}\left\{\frac{600}{RT}\right\}$ $R = 2\ \text{cal/K} - \text{mol}$

$2\ln 10 = \frac{600}{2T}$

$T = \left\{\frac{300}{2 \times 2.303}\right\} K$

37. **(1)**

The rate of an electrophilic aromatic substitution reaction depends upon the stability of the arenium ion which is formed as an intermediate during the reaction. The group which stabilises the arenium ion gives the substitution reaction at a faster rate, while the group which decreases the stability, gives the reaction at a slower rate.

Among the given options, $-OCH_3$, $-C_2H_5$ increase the electron density while $-Br$, $-NO_2$ decrease the electron density, therefore the correct order is: $2 > 3 > 1 > 5 > 4$

38. **(4)** Bond order of O_2^-, O_2, $O_2^+$and O_2^{2-} are 1.5, 2.0, 2.5 and 1.0 respectively. Bond length is inversely proportional to bond order.

$\therefore$ $O - O$ bond length is largest in k_2O_2.

39. **(1)** $\because M \times V(ml) = m\ mol$

10 m mol H_2SO_4 = 20 m mol of NH_3

$[H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2SO_4]$

1 mol NH_3 contains 14 g nitrogen

20×10^{-3} mol NH_3 contains $14 \times 20 \times 10^{-3}$ nitrogen

0.75 g of sample contains

% Nitrogen $= \frac{14 \times 20 \times 10^{-3}}{0.75} \times 100 = 37.33\%$

40. **(3)** Let the volume of NaOH is V_1, Volume of HCN is V_2 :

Meq of HCN $= V_2 - V_1$

Mcq of NaCN $= V_1$

As the pH of buffer solution is 4.72 which is equal to pk_a of HCN . Hence this is a condition of Half of Neutralization.

$4.72 = 4.72 + \log \frac{V_1}{(V_2 - V_1)}$

but $\frac{V_1}{V_2 - V_1} = 1$

$V_1 = V_2 - V_1$

$2V_1 = V_2$

$V_1/V_2 = 1/2$

Hence volume of $\mathrm{HCN} : \mathrm{NaCN} = 2 : 1$.

41. (4)

Protein found in a biological system with a unique three-dimensional structure and biological activity is called a native protein. When a protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called denaturation of protein.

The coagulation of egg white on boiling is a common example of denaturation. Another example is curdling of milk which is caused due to the formation of lactic acid by the bacteria present in milk.

During denaturation secondary and tertiary structures are destroyed but primary structure remains intact.

Hence,(A) is false but (R) is true

42. (1) Answer (A)

Basicity follows the order :

$\mathrm{NH_3} > \mathrm{PH_3} > \mathrm{AsH_3} > \mathrm{SbH_3} \geq \mathrm{BiH_3}$

Reducing strength follows the order:

$\mathrm{NH_3} < \mathrm{PH_3} < \mathrm{AsH_3} < \mathrm{SbH_3} < \mathrm{BiH_3}$

A: Basicity is maximum for $\mathrm{NH_3}$, but reducing strength increases down the group, so $\mathrm{NH_3}$ does not have maximum reducing strength. This statement is incorrect.

B: The standard enthalpy of formation is negative only for $\mathrm{NH_3}$, as it is thermodynamically stable. For other hydrides, it is positive due to weaker bonds. This is correct.

C: The bond angle decreases down the group $(\mathrm{NH_3} > \mathrm{PH_3} > \mathrm{AsH_3} > \mathrm{SbH_3})$ because the size of the central atom increases, reducing lone pair-bond pair repulsion. This is correct.

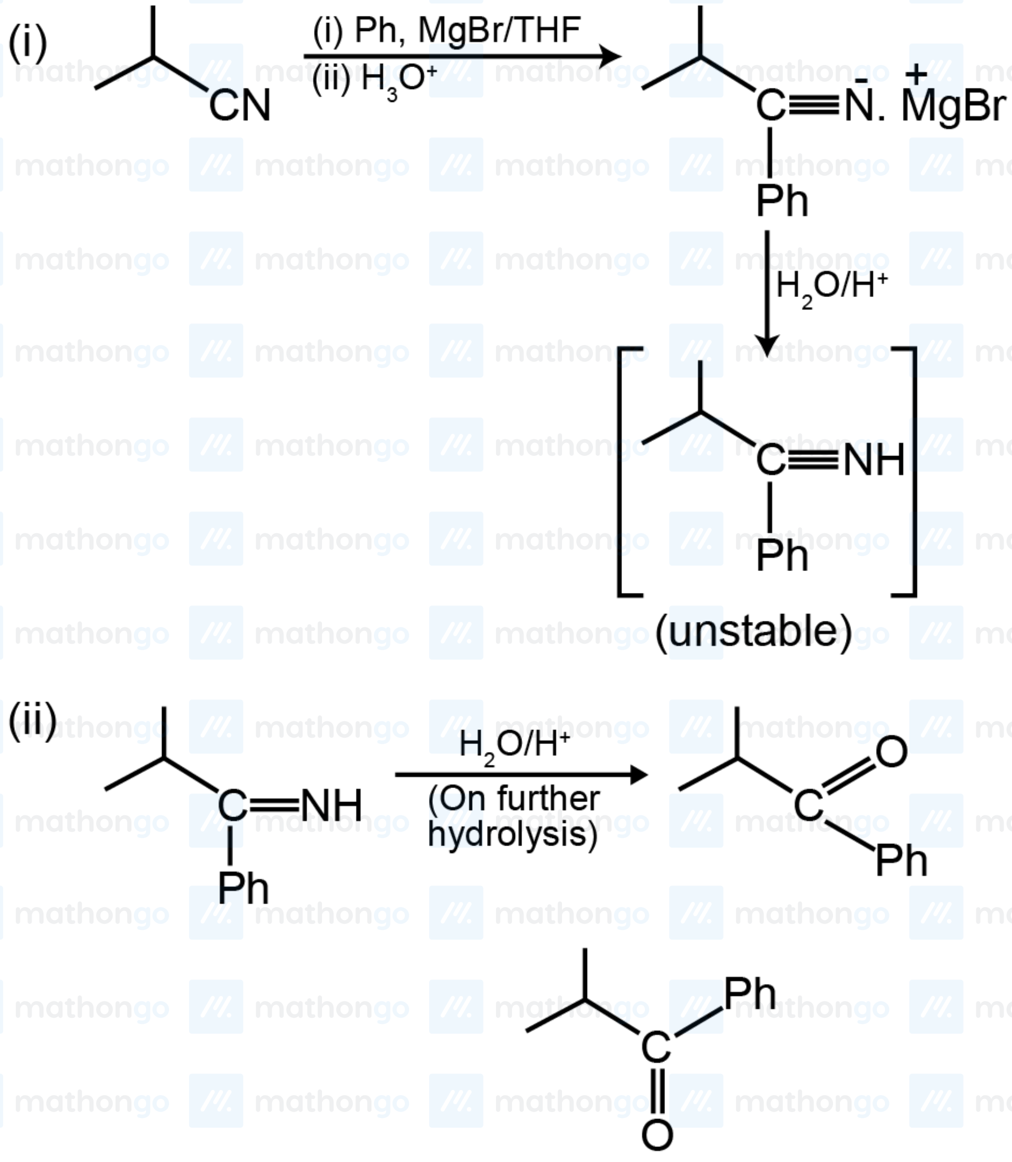
D: Boiling points follow the order $\mathrm{PH_3} < \mathrm{AsH_3} < \mathrm{SbH_3} < \mathrm{NH_3}$, with $\mathrm{NH_3}$ being anomalously high due to hydrogen bonding. The statement $\mathrm{PH_3} < \mathrm{AsH_3} < \mathrm{NH_3} < \mathrm{SbH_3}$ is incorrect.

43. (3) Red ppt is $[\mathrm{Ni(dmg)_2}]$

Here Ni is in $+2$ oxidation state

It is diamagnetic and dsp^2 hybridized

44. **(2)** The given reaction occurs as follows :



45. **(2)** $Cr_2O_7^{2-} + 6Fe^{2+}(n = 1)$ (Mohr's salt) $+14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

Equivalent of Fe^{2+} = moles of Mohr's salt

$= \text{equivalent of } K_2Cr_2O_7$

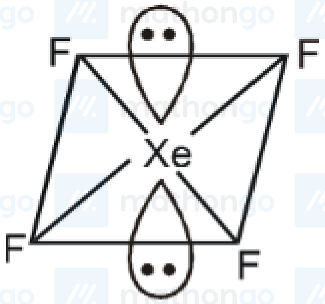
$= 500 \times 10^{-3} \times 6 \times 1 = 3$

Hence mole percent of Mohr's salt

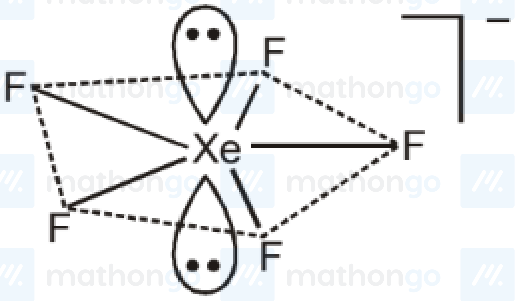
$= \frac{3}{6} \times 100 = 50$

46.

XeF_4

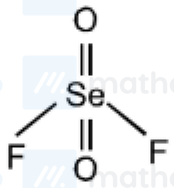


XeF_5^-

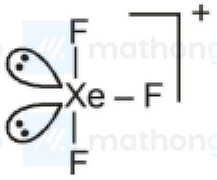


(5)

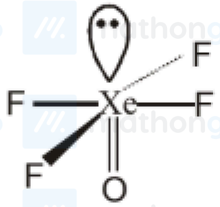
F_2SeO_2



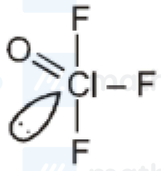
XeF_3^+



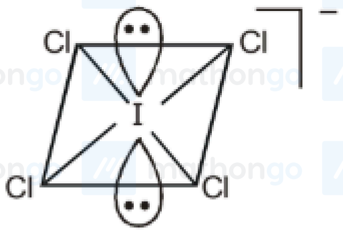
$XeOF_4$



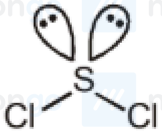
$ClOF_3$



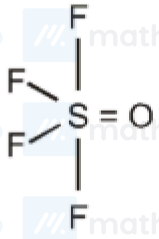
ICl_4^-



SCl_2



OSF_4



47. (6000) $\mathrm{Fe} + 2\mathrm{HCl} \rightarrow \mathrm{FeCl_2} + \mathrm{H_2}$

Moles of $Fe = \frac{112}{56} = 2$

Moles of H_2 formed $= 2$ Work done $= P\left(V_2 - V_1\right) = P.V_{H_2}\left[V_2 = V_{H_2}\right.$ and $V_1 = 0$ (for solid+liquid state)

$= P \times \frac{nRT}{P} = nRT\ (\because P_{H_2} \times V = nRT)$

$= 2 \times 2 \times 300 = 1200\mathrm{cal}$

48. **(20)** $A : H_2O \rightarrow \frac{1}{2}O_2 + 2H^+ + 2e^-$

$C : Cu^{2+} + 2e^- \rightarrow Cu$

1 mole of $e^- = 1$ mole of H^+

$\because pH = 1 \Rightarrow [H^+] = 0.1$

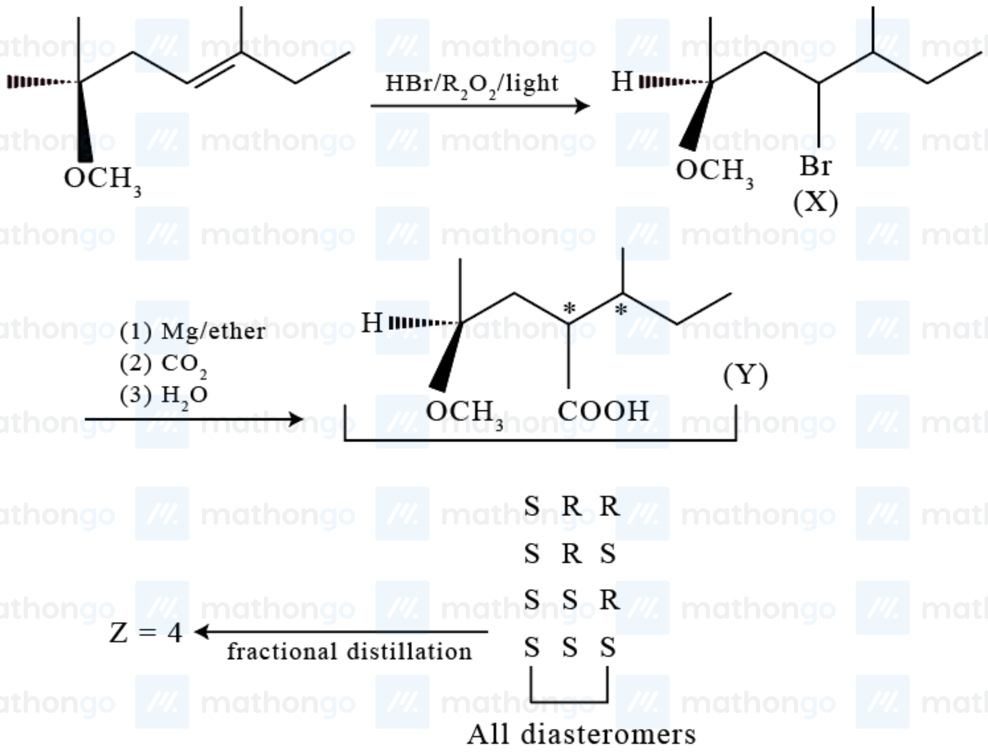
$\therefore$ Faradays $= 0.1 = \dfrac{0.965 \times t}{96500} \times \dfrac{20}{100}$

$\Rightarrow t = 5 \times 10^4 sec$

$x = 5, y = 4$

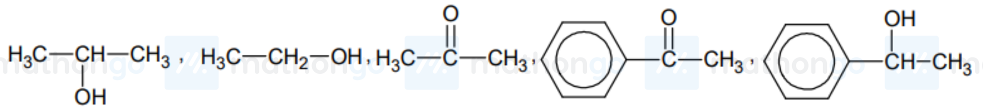
$25y/x = 20$

49.



(4)

50. **(5)** The following compounds give positive iodoform test



Compound 1 $(CH_3 - CH(OH) - CH_3)$:

This compound contains a secondary alcohol group $-CH(OH) - CH_3$, which meets the criteria for the Iodoform test. It will give a positive result.

Compound 2 $(CH_3 - CH_2 - CH_2 - OH)$:

This is a primary alcohol with a $-CH_2OH$ group, which does not meet the criteria for the Iodoform test. It will not give a positive result.

Compound 3 $(CH_3-CH_2-CH(OH)-CH_3)$:
This compound also contains a secondary alcohol group $-CH(OH)-CH_3$, which will give a positive result in the Iodoform test.

Compound 4 $(CH_3-CO-CH_3)$:
A methyl ketone, $-COCH_3$, is present, which meets the criteria for the Iodoform test. This compound will give a positive result.

Compound 5 (Phenyl-methyl ketone, $C_6H_5-CO-CH_3$):
This compound contains a methyl ketone group $-COCH_3$, so it will also give a positive result in the Iodoform test.

Compound 6 $(CH_3-CH(OH)-CH_2-CH_3)$:
This is a secondary alcohol, but it does not have the required $-CH(OH)-CH_3$ group for the Iodoform test. It will not give a positive result.

Compound 7 $(CH_3-CO-CH_2-CH_3)$:
This is a ketone, but it does not have a methyl ketone group $(-COCH_3)$, so it will not give a positive result.

Compound 8 $(CH_3-CO-NH_2)$:
This is an amide, not a ketone or alcohol, so it does not meet the criteria for the Iodoform test. It will not give a positive result.

Compound 9 $(CH_3-CH_2-CO-CH_3)$:
This compound contains a methyl ketone group $-COCH_3$, so it will give a positive result in the Iodoform test.

51. **(4)** We have $n=20, \bar{x}_{\text{old}}=10, Var_{\text{old}}=4$

$$\Rightarrow \bar{x}=\frac{\Sigma x_i}{20} \Rightarrow \Sigma x_i=200$$

$$\Rightarrow (\Sigma x_i)_{\text{new}}=192, \bar{X}_{\text{new}}=\frac{192}{9}$$

$$\text{Var}_{(\text{old})}=\frac{\Sigma x_i^2}{20}-(\bar{x}_{\text{old}})^2$$

$$4=\frac{\Sigma x_i^2}{20}-100$$

$$\Sigma x_{i(\text{old})}^2=2080$$

$$\Sigma x_{i_{\text{new}}}^2=2080-64=2016$$

$$\text{Var}_{(\text{new})}=\frac{2016}{19}-\left(\frac{192}{19}\right)^2=\frac{1440}{361}$$

52. **(1)** $\left(2xy^4e^y+2xy^3+y\right)dx+\left(x^2y^4e^y-x^2y^2-3x\right)dy=0$

Dividing both the sides by y^4, we get $\left\{2xe^y+\left(\frac{2x}{y}\right)+\left(\frac{1}{y^3}\right)\right\}dx+\left(x^2e^y-\frac{x^2}{y^2}-\frac{3x}{y^4}\right)dy=0$

$$\Rightarrow \left(2xe^{y}dx + x^{2}e^{y}dy\right) + \left(2x\frac{dx}{y} - \frac{x^{2}}{y^{2}}dy\right) + \left(\frac{dx}{y^{3}} - \frac{3xdy}{y^{4}}\right) = 0$$

$$\Rightarrow d\left(x^{2}e^{y}\right) + d\left(\frac{x^{2}}{y}\right) + d\left(\frac{x}{y^{3}}\right) = 0$$

$$\therefore x^{2}e^{y} + \frac{x^{2}}{y} + \frac{x}{y^{3}} = c$$

53. **(1)** $h(p) = \frac{1}{2}(h(p+1) + h(p-1)) \Rightarrow h(p-1), h(p), h(p+1)$ are in A.P.

$h(100) = h(0) + 99d$

$\Rightarrow \frac{20-5}{99} = d \Rightarrow d = \frac{15}{99} \Rightarrow h(1) = h(0) + d = 5 + \frac{15}{99} = 5.15$

54. **(1)**

$\alpha + \beta = 1, \alpha\beta = 2$

$\alpha^{2} + \beta^{2} = -3$

$\alpha^{3} + \beta^{3} = -5$

$\alpha^{4} + \beta^{4} = 1$

$\alpha^{5} + \beta^{5} = 11$

$$\frac{\sum_{n=1}^{5} S_n}{\sum_{n=1}^{4} \alpha^{n} + \sum_{n=1}^{4} \beta^{n} + 7} = \frac{S_1 + S_2 + S_3 + S_4 + S_5}{S_1 + S_2 + S_3 + S_4 + 7} = 5$$

55. **(1)** $\because \quad T_r(A) = a + b + c = 10; \quad (a \neq b \neq c)$

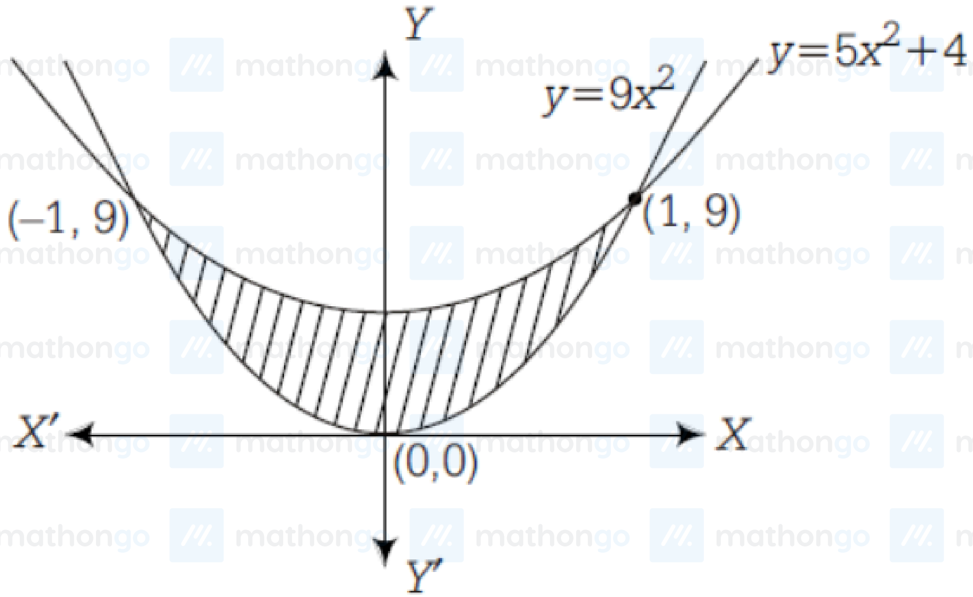
Therefore it may be $(1, 3, 6), (1, 4, 5), (2, 3, 5)$

So, number of choices for $(a, b, c) = 3! \times 3$

Also, nurober of ways of arranging diagonal elements $= 3!$

$\therefore$ number of matrices $= 3(3!)^{2}$

56. **(2)** Intersecting point of $y = 9x^{2}$ and $y = 5x^{2} + 4$ is given by



$9x^{2} = 5x^{2} + 4$

$$\begin{aligned}&\Rightarrow \quad 4x^2=4\\&\Rightarrow \quad x^2=1\\&\Rightarrow \quad x=\pm1\\&\therefore \quad y=9(\pm1)^2=9\end{aligned}$$

Hence, intersecting points are $(\pm1,9)$.

$$\begin{aligned}\therefore \text{ Required area } &= 2\int_0^1\left[\left(5x^2+4\right)-\left(9x^2\right)\right]dx\\&=2\int_0^1\left(4-4x^2\right)dx\\&=2\left[4x-\frac{4x^3}{3}\right]_0^1\\&=2\left(4-\frac{4}{3}\right)-(0-0)=2\times\frac{8}{3}\\&=\frac{16}{3}\text{ sq units}\end{aligned}$$

57. **(1)** A : exactly one child

B : exactly two children

C : exactly 3 children

$\mathrm{P(A)}=\frac{1}{4};\mathrm{P(B)}=\frac{1}{2};\mathrm{P(C)}=\frac{1}{4}$

E : couple has exactly 4 grandchildren

$$P(E)=P(A)\cdot P(E/A)+P(B)\cdot P(E/B)+P(C)\cdot P(E/C)$$

$$=\frac{1}{4}\times0+\frac{1}{2}\left[\left(\frac{1}{2}\right)^2+\frac{1}{4}\times\frac{1}{4}\times2\right]+\frac{1}{4}\left[3\left(\frac{1}{4}\times\frac{1}{4}\times\frac{1}{2}\right)\right]$$

$$=\frac{1}{8}+\frac{1}{16}+\frac{3}{128}=\frac{27}{128}$$

58. **(1)** Given vectors $\vec{a}=3\hat{i}+\hat{j}-\hat{k},\vec{b}=\hat{i}-4\hat{j}+5\hat{k}$ and $\vec{c}=4\hat{i}+5\hat{j}-\hat{k}$

$$\because \vec{b}\times\vec{c}=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\1&-4&5\\4&5&-1\end{vmatrix}=\hat{i}(4-25)-\hat{j}(-1-20)+\hat{k}(5+16)$$

$$=-21\hat{i}+21\hat{j}+21\hat{k}=21(-\hat{i}+\hat{j}+\hat{k})$$

$$\Rightarrow |\vec{b}\times\vec{c}|=21\sqrt{3}$$

Now, vector $\vec{r}$, which is perpendicular to b and $\vec{c}$, so

$$\vec{r} = \pm|\vec{r}|\frac{\vec{b}\times\vec{c}}{|\vec{b}\times\vec{c}|}$$

$$\because \vec{r}\cdot\vec{a} = 9$$

$$\Rightarrow \pm\frac{|\vec{r}|}{|\vec{b}\times\vec{c}|}[21(-\hat{i}+\hat{j}+\hat{k})\cdot(3\hat{i}+\hat{j}-\hat{k})] = 9$$

$$\Rightarrow \pm\frac{|\vec{r}|}{21\sqrt{3}}[21(-3+1-1)] = 9$$

$$\Rightarrow |\vec{r}| = 3\sqrt{3}\quad(\because |\vec{r}|>0)$$

$$\therefore \vec{r} = -3\sqrt{3}\frac{21(-\hat{i}+\hat{j}+\hat{k})}{21\sqrt{3}} = -3(-\hat{i}+\hat{j}+\hat{k})$$

$$= 3(\hat{i}-\hat{j}-\hat{k})$$

59. **(2)** Let

$$A = \int_0^2 y\,dx$$

$$\frac{dy}{y+A} = dx$$

Its solution is

$\ln(y+A) = x + c$

Given

$y(0) = 1,$ so $c = \ln(1+A)$

$y = (1+A)e^x - A$

$$A = \int_0^2 y\,dx = \int_0^2 ((1+A)e^x - A)\,dx = \frac{e^2-1}{4-e^2}$$

Hence solution is

$y(x) = \frac{3e^x - e^2 + 1}{4-e^2}$

60. **(2)** Here $f'(x) = \begin{cases} 4-3x^2 & 2\le x<3 \\ 1 & x\ge 3\end{cases}$.

$\Rightarrow f(x)$ is decreasing in $[2,3)$ and increasing in $[3,\infty)$.

Now, $f(x)$ will have least value at $x=3$ if

$$= \lim_{x\to 3^-} f(x) \ge f(3) \text{ i.e. } -15 + \ln\left(b^2-3b+3\right) \ge -15$$

$$\text{i.e. } \ln\left(b^2-3b+3\right) \ge 0$$

$$\Rightarrow \quad b^2-3b+3\ge 1 \quad \text{i.e.} \quad b^2-3b+2\ge 0$$

$$\text{i.e.} \quad b\in(-\infty,1]\cup[2,\infty).$$

61. **(1)** $\tan^{-1}\left(\frac{1}{2}\right) + \tan^{-1}\left(\frac{2}{3x}\right) + \tan^{-1}\left(\frac{3}{4}\right) = \frac{\pi}{2}$

Let $\alpha = \tan^{-1}\left(\frac{1}{2}\right), \beta = \tan^{-1}\left(\frac{2}{3x}\right)$, and $\gamma = \tan^{-1}\left(\frac{3}{4}\right)$.

$\tan(\alpha+\beta+\gamma) = \frac{\tan(\alpha)+\tan(\beta)+\tan(\gamma)-\tan(\alpha)\tan(\beta)\tan(\gamma)}{1-[\tan(\alpha)\tan(\beta)+\tan(\beta)\tan(\gamma)+\tan(\gamma)\tan(\alpha)]} =$ unidentified

Substituting $\tan(\alpha) = \frac{1}{2}, \tan(\gamma) = \frac{3}{4}$, and $\tan(\beta) = \frac{2}{3x}$, we simplify to find x.

Solving this equation gives $x = \frac{7}{24}$.

Now,

$\tan\left(\pi-2\tan^{-1}x\right)=-\tan\left(2\tan^{-1}x\right)$

and $\tan\left(2\tan^{-1}x\right)=\frac{2x}{1-x^2}$.

Substituting $x=\frac{7}{24}$:

$\tan\left(2\tan^{-1}x\right)=\frac{2\cdot\frac{7}{24}}{1-\left(\frac{7}{24}\right)^2}=\frac{\frac{14}{24}}{1-\frac{49}{576}}=\frac{\frac{14}{24}}{\frac{524}{576}}=\frac{14\cdot576}{24\cdot527}=\frac{24}{7}$

62.

(3)

$\Rightarrow |z|^2+2(z+\bar{z})-5=0$

$\Rightarrow z\bar{z}+2z+2\bar{z}-5=0$

$\Rightarrow z_0=-2 \quad r=\sqrt{4+5}=3$

$\Rightarrow |z+2|=3$

Now, let $w=z+3+2i$

$\Rightarrow w-1-2i=2+2$

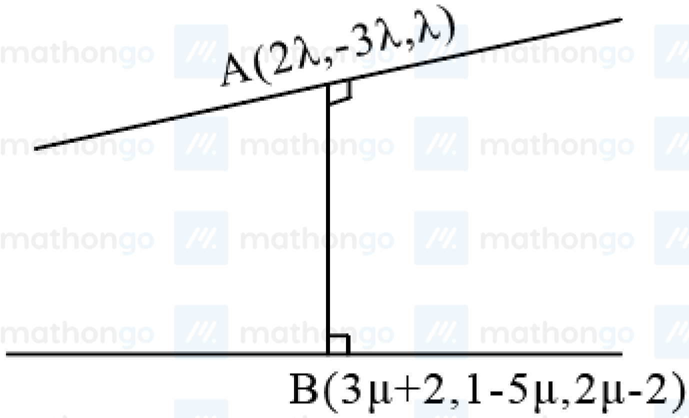
$\Rightarrow |w-1-2i|=|2+2|$

$\Rightarrow |w-(1+2i)|=3$

Hence, w lies on circle with centre $1+2i$ and radius 3

63.

(3) Line has direction $\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & -3 & 1\\ 3 & -5 & 2\end{vmatrix}=-\hat{i}-\hat{j}-\hat{k}$



$2\lambda-3\mu-2=5\mu-3\lambda-1=\lambda+2-2\mu$

$\Rightarrow$ Solving $\lambda=\frac{31}{3}$ & $\mu=\frac{19}{3}$

Point B is $\left(21,-\frac{92}{3},\frac{32}{3}\right)$

64.

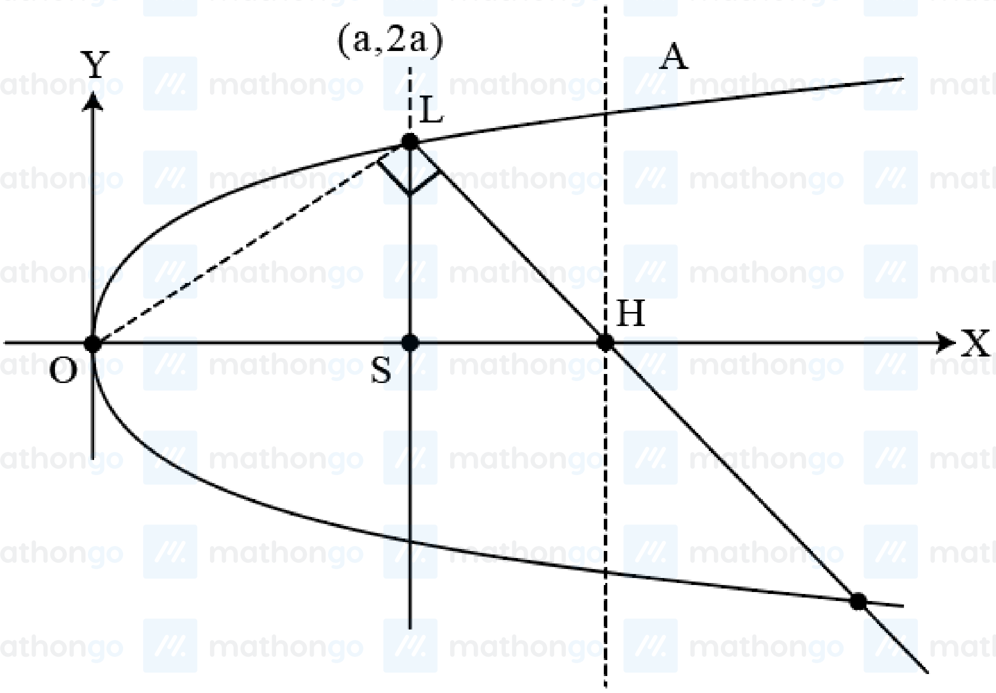
(4) $\begin{vmatrix}1 & \sin\alpha & \sin^2\alpha\\ 1 & \cos\alpha & \cos^2\alpha\\ 1 & \sin2\alpha & \sin^22\alpha\end{vmatrix}=0$

$\Rightarrow (\sin\alpha-\cos\alpha)(\cos\alpha-\sin2\alpha)(\sin2\alpha-\sin\alpha)=0$

$\Rightarrow \tan\alpha=1,\cos\alpha=0,\sin\alpha=\frac{1}{2},\sin\alpha=0,\cos\alpha=\frac{1}{2}$

$\Rightarrow \alpha=0,\frac{\pi}{6},\frac{\pi}{4},\frac{\pi}{3},\frac{\pi}{2},\frac{5\pi}{6}\&\pi$

65.



(2)

slope of $OL = \frac{2a}{a} = 2$

$\Rightarrow$ slope of $LH = -\frac{1}{2}$

So, equation of LH is given by

$y - 2a = -\frac{1}{2}(x - a)$

$\therefore$ Co-ordinate of H are given by $H : (5a, 0)$

For double ordinate, put $x = 5a$ in

$y^2 = 4ax \Rightarrow y^2 = (4a)(5a) \Rightarrow y^2 = 20a^2 \Rightarrow y = \pm 2\sqrt{5}a$

$\Rightarrow$ length $= 4\sqrt{5}a$ units

66. Let $\frac{\ell}{n} = a, \frac{m}{n} = b$

(2) So, the equations are

$2a + \lambda b + 1 = 0$

$b + a - 5ab = 0$

$\Rightarrow b = \frac{a}{5a-1}, a = \frac{b}{5b-1}$

Putting b in first equation,

$$(2a + 1) + \lambda\left(\frac{a}{5a - 1}\right) = 0$$

$\Rightarrow 10a^2 + a(\lambda + 3) - 1 = 0$

$\Rightarrow a_1 a_2 = \frac{-1}{10}$

Similarly, $b_1 b_2 = \frac{-1}{5\lambda}$

Since, $\ell_1\ell_2 + m_1m_2 + n_1m_2 = 0$

$\Rightarrow a_1a_2 + b_1b_2 + 1 = 0$

$\Rightarrow \dfrac{1}{10} - \dfrac{1}{5\lambda} + 1 = 0$

$\Rightarrow \lambda = \dfrac{2}{9}$

67. **(4)** Replacing x by $x+1$

$f(x+2) = \frac{f(x+1)-1}{f(x+1)+1}$

$= \dfrac{\frac{f(x)-1}{f(x)+1}-1}{\frac{f(x)-1}{f(x)+1}+1} = \frac{-2}{2f(x)} = \frac{-1}{f(x)}$

Replacing x by $x+2$

$$f(x+3) = \frac{f(x+2)-1}{f(x+2)+1} = \frac{-\frac{1}{f(x)}-1}{-\frac{1}{f(x)}+1} = \frac{1+f(x)}{1-f(x)}$$

Replacing x by $x+3$

$$f(x+4) = \frac{f(x+3)-1}{f(x+3)+1} = \frac{\frac{1+f(x)}{1-f(x)}-1}{\frac{1+f(x)}{1-f(x)}+1}$$

$$= \frac{2f(x)}{2} = f(x)$$

$$\therefore \quad f(999) = f(4\times 249+3) = f(3) = -\frac{1}{2}$$

$$\left\{\because \quad f(2) = \frac{f(1)-1}{f(1)+1} = \frac{1}{3},\right.$$

$$\left. f(3) = \frac{f(2)-1}{f(2)+1} = \frac{\frac{1}{3}-1}{\frac{1}{3}+1} = -\frac{1}{2}\right\}$$

68.

$$\lim_{n\to\infty}\tan^{-1}\left\{4n^2\left(1-\cos\frac{x}{n}\right)\right\} = \lim_{n\to\infty}\tan^{-1}\frac{\left\{4\left(1-\cos\frac{x}{n}\right)\cdot x^2\right\}}{\frac{x^2}{n^2}}$$

$$= \tan^{-1}2x^2\left\{\because \lim_{\theta\to 0}\frac{1-\cos\theta}{\theta^2} = \frac{1}{2}\right\}$$

(4) $\Rightarrow f(x) = \tan^{-1}2x^2$

$$\text{and } \lim_{n\to\infty}\frac{n^2}{2}\ell n\cos\left(\frac{2x}{n}\right) = \lim_{n\to\infty}\frac{n^2}{2}\ell n\left\{1+\cos\frac{2x}{n}-1\right\}$$

$$= \lim_{n\to\infty}\frac{n^2\ell n\left\{1+\left(\cos\frac{2x}{n}-1\right)\right\}}{2\left(\cos\frac{2x}{n}-1\right)}\times\left(\cos\frac{2x}{n}-1\right)$$

$$= \frac{1}{2}\lim_{n\to\infty}\frac{\ln\left\{1+\left(\cos\frac{2x}{n}-1\right)\right\}}{\cos\frac{2x}{n}-1}\times\lim_{n\to\infty}\left(\frac{\cos\frac{2x}{n}-1}{\frac{4x^2}{n^2}}\right)\cdot 4x^2$$

$\Rightarrow g(x) = -x^2$

$\lim_{x\to 0}\frac{\tan^{-1}(2x^2)-2x^2}{x^6} = \frac{-8}{3}$

69. **(3)** Let, $I=\int \frac{x^{pq-p-1}}{\left(x^p+1\right)^8} dx$

On taking x^p common from denominator and simplifying

$I=\int \frac{x^{-p-1}}{\left(1+x^{-p}\right)^q} dx$

Let, $1+x^{-p}=t$

$$=\frac{-1}{p} \int \frac{dt}{t^q}$$

$$=-\frac{t^{-q+1}}{p(1-q)}+c$$

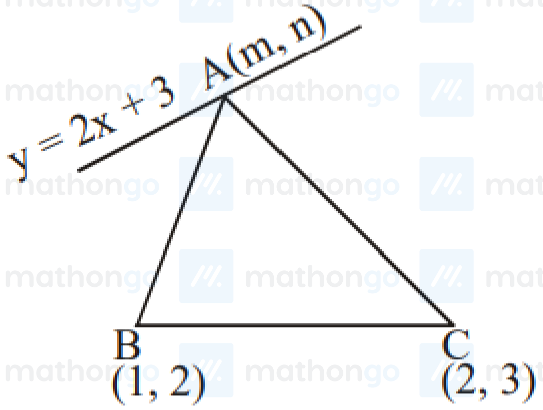
$\therefore \frac{2}{\lambda}=1 \Rightarrow \lambda=2$

70. As $A(m, n)$ lies on $y=2x+3$

(3) $\Rightarrow n=2m+3$

$\therefore \quad A=(m, 2m+3)$

$$\text{Area of } \triangle \mathrm{ABC}=\frac{1}{2}\left|\begin{array}{ccc}\mathrm{m} & 2\mathrm{~m}+3 & 1 \\ 1 & 2 & 1 \\ 2 & 3 & 1\end{array}\right|=\frac{1}{2}(\mathrm{~m}+2)=\mathrm{S} \text{ (Given)}$$



But $[\mathrm{S}]=2 \Rightarrow 2 \leq \mathrm{S}<3$

$\Rightarrow \quad 4 \leq m+2<6$

$\Rightarrow \quad 2 \leq m<4$

But $m \in N$

$\therefore m=2, 3$

For $m=2, n=7$

For $m=3, n=9$

Since $m+n>10$,

$\therefore m=3, n=9$

$\Rightarrow A(3, 9)$

$\therefore$ equation of AC is

$6x-y=9$

71. **(7)** Required number of ways

$=$ Total when all A's are separated $-$ Total when A's separated and H's are together

$$= \frac{7!}{2!}\left({}^{8}C_4\right) - 6!\left({}^{7}C_4\right)$$

$$= \frac{7!\cdot 6!}{4!\cdot 3!}(6) = 4^1\cdot 5^2\cdot 6^3\cdot 7^1$$

72. **(3)** $\overrightarrow{x}\times\overrightarrow{z} = \overrightarrow{x}\times\overrightarrow{y}$

$\overrightarrow{x}\times(\overrightarrow{z}-\overrightarrow{y}) = 0$

$\overrightarrow{z}-\overrightarrow{y} = \lambda\overrightarrow{x}$

$\overrightarrow{z} = \overrightarrow{y}+\lambda\overrightarrow{x} = 2\hat{i}+4\hat{j}+\hat{k}+\lambda(\hat{i}+3\hat{j}-2\hat{k})$

$\overrightarrow{z} = (2+\lambda)\hat{i}+\hat{j}(4+3\lambda)+\hat{k}(1-2\lambda)$

$\vec{z}\cdot\vec{x} = 0 \Rightarrow 2+\lambda+3(4+3\lambda)-2(1-2\lambda) = 0$

$2+\lambda+12+9\lambda-2+4\lambda = 0$

$14\lambda = -12$

$\lambda = -\frac{6}{7}$

so $\overrightarrow{z} = \frac{8}{7}\hat{i}+\frac{10}{7}\hat{j}+\frac{19}{7}\hat{k}$

$|\overrightarrow{z}| = \frac{1}{7}\sqrt{8^2+10^2+19^2}$

$[|\vec{z}|] = 3$

73. **(7)** We know, $[f(x)]$ may be discontinuous at points where $f(x) = $ integer.

So, we need to check for $x = -1, \frac{-2}{3}, \frac{-1}{2}, \frac{-1}{3}, 0, \frac{1}{3}, \frac{1}{2}, \frac{2}{3}, 1$

Point	LHL	RHL	$f(x)$	Continuous
$x=-1$	$\times$	-4	-4	Yes
$x=-2/3$	$-13/3$	$-1/3$	$-1/3$	No
$x=-1/2$	$-1/2$	-3.5	-3.5	No
$x=-1/3$	$-11/3$	$1/3$	$1/3$	No
$x=0$	0	0	0	Yes
$x=1/3$	$1/3$	$13/3$	$13/3$	No
$x=1/2$	$9/2$	$3/2$	$3/2$	No
$x=2/3$	$5/3$	$17/3$	$17/3$	No
$x=1$	6	$\times$	8	No

74. $(1+x^2)^{10}(1-x^2)^6(1+x^3)^8$

$= (1-x^4)^6(1+x^2)^4(1+x^3)^8$

(0) $= \left[{}^{6}c_0 - {}^{6}c_1x^4+\cdots\right]\left[4c_0+4c_1x^2+4c_2x^4+\cdots\right]\left[{}^{8}c_0+{}^{8}c_1x^3+\cdots\right]$

coefficient of $x^4 = {}^{6}c_0\times{}^{4}c_2\times{}^{8}c_0 - {}^{6}c_1\times{}^{4}c_0\times{}^{8}c_0$

$= 6-6 = 0$

75.

(3) $I = \int_{\frac{-1}{\sqrt[3]{n}}}^{\frac{1}{\sqrt[3]{n}}} x\ln\left(1+e^x+e^{2x}+\ldots.e^{2nx}\right)dx$

Using king's property

$$I=\int_{\frac{-1}{\sqrt[3]{n}}}^{\frac{1}{\sqrt[3]{n}}} x\ln\left(1+\frac{1}{e^x}+\frac{1}{e^{2x}}+\ldots\cdot\frac{1}{e^{2nx}}\right)dx$$

$$=\int_{\frac{-1}{\sqrt[3]{n}}}^{+\frac{1}{\sqrt[3]{n}}} -x\ln\left(\frac{e^{2nx}+e^{(2n-1)x}+\ldots\ldots\ldots+e^x+1}{e^{2nx}}\right)dx$$

$$I=-I+\int_{\frac{-1}{\sqrt[3]{n}}}^{+\frac{1}{\sqrt[3]{n}}} x\ln e^{2nx}dx$$

$$\therefore 2I=2n\left(\frac{x^3}{3}\right)_{\frac{-1}{\sqrt[3]{n}}}^{\frac{1}{\sqrt[3]{n}}}=2n\left(\frac{1}{3n}+\frac{1}{3n}\right)=\frac{4}{3}$$

$$\therefore I=\frac{2}{3}$$

$$\because \prod_{k=2}^{m}\left(1-\frac{1}{k^2}\right)=\prod_{k=2}^{m}\frac{(k-1)}{k}\frac{(k+1)}{k}$$

$$=\left(\frac{1}{2}\cdot\frac{2}{3}\cdot\ldots\ldots\cdot\frac{(m-1)}{m}\right)\left(\frac{3}{2}\cdot\frac{4}{3}\cdot\frac{5}{3}\cdot\ldots\ldots\cdot\frac{(m+1)}{m}\right)$$

$$=\frac{(m+1)}{2m}$$

$$\therefore \frac{2}{3}=\frac{m+1}{2m}\Rightarrow 4m=3m+3\Rightarrow m=3$$